Wound healing of human embryonic stem cell-derived retinal pigment epithelial cells is affected by maturation stage

Background: Wound healing of retinal pigment epithelium (RPE) is a complex process that may take place in common age-related macular degeneration eye disease. The purpose of this study was to evaluate whether wounding and wound healing has an effect on Ca^{2+} dynamics in human embryonic stem cell (hESC)-RPEs cultured different periods of time. Methods: The 9-day-cultured or 28-day-cultured hESC-RPEs from two different cell lines were wounded and the dynamics of spontaneous and mechanically induced intracellular Ca^{2+} activity was measured with live-cell Ca^{2+} imaging either immediately or 7days after wounding. The healing time and speed were analyzed with time-lapse bright field microscopy. The Ca^{2+} activity and healing speed were analysed with image analysis. In addition the extracellular matrix deposition was assessed with confocal microscopy. Results: The Ca^{2+} dynamics in hESC-RPE monolayers differed depending on the culture time: 9-day-cultured cells had higher number of cells with spontaneous Ca^{2+} activity close to freshly wounded edge compared to control areas, whereas in 28-day-cultured cells there was no difference in wounded and control areas. The 28-day-cultured, wounded and 7-day-healed hESC-RPEs produced wide-spreading intercellular Ca^{2+} waves upon mechanical stimulation, while in controls propagation was restricted. Most importantly, both wave spreading and spontaneous Ca^{2+} activity of cells within the healed area, as well as the cell morphology of 28-day-cultured, wounded and thereafter 7-day-healed areas resembled the 9-day-cultured hESC-RPEs. Conclusions: This acquired knowledge about Ca^{2+} dynamics of wounded hESC-RPE monolayers is important for understanding the dynamics of RPE wound healing, and could offer a reliable functionality test for RPE cells. The data presented in here suggests that assessment of Ca^{2+} dynamics analysed with image analysis could be used as a reliable non-invasive functionality test for RPE cells.

General information

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MoE publication type: A1 Journal article-refereed
Organisations: Faculty of Biomedical Sciences and Engineering, Research group: Computational Biophysics and Imaging Group, University of Eastern Finland, University Central Hospital Kuopio
Contributors: Abu Khamidakh, A. E., Rodriguez-Martinez, A., Kaarniranta, K., Kallioniemi, A., Skottman, H., Hyttinen, J., Juuti-Uusitalo, K.
Publication date: 31 Jul 2018
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ASJC Scopus subject areas: Radiological and Ultrasound Technology, Biomaterials, Biomedical Engineering, Radiology Nuclear Medicine and imaging
Keywords: Ca waves, Cell maturation, HESC-RPE, Image analysis, Mechanical stimulation, Mechanically induced intercellular Ca waves, RPE, Spontaneous [Ca] increases, Wound healing
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Research output: Contribution to journal › Article › Scientific › peer-review

Composites of poly(L-lactide-co-caprolactone) and tricalcium phosphate containing antibiotics; Degradation and drug release

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Department of Biomedical Engineering, Department of Electronics and Communications Engineering, Department of Chemistry and Bioengineering, Integrated Technologies for Tissue Engineering Research (ITTE), Bioretec Ltd., Adult Stem Cells
Contributors: Ahola, N., Veiranto, M., Männistö, N., Kellomäki, M.
Publication date: 2011

Host publication information

Title of host publication: 24th European Conference on Biomaterials - Annual Conference of the European Society for Biomaterials, ESB 2011
ASJC Scopus subject areas: Biomaterials
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http://www.scopus.com/inward/record.url?scp=84886997318&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84886997318
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Effects of chitosan and bioactive glass modifications of knitted and rolled polylactide-based 96/4L/D scaffolds on chondrogenic differentiation of adipose stem cells

The performance of biodegradable knitted and rolled 3-dimensional (3D) polylactide-based 96/4 scaffolds modified with bioactive glass (BaG) 13-93, chitosan and both was compared with regard to the viability, proliferation and chondrogenic differentiation of rabbit adipose stem cells (ASCs). Scaffold porosities were determined by micro-computed tomography (μCT). Water absorption and degradation of scaffolds were studied during 28-day hydrolysis in Tris-buffer. Viability, number and differentiation of ASCs in PLA96/4 scaffolds were examined in vitro. The dimensions of the scaffolds were maintained during hydrolysis and mass loss was detected only in the BaG13-93 containing scaffolds. ASCs adhered and proliferated on each scaffold type. Cell aggregation and expression of chondral matrix components improved in all scaffold types in chondrogenic medium. Signs of hypertrophy were detected in the modified scaffolds but not in the plain PLA96/4 scaffold. Chondrogenic differentiation was most enhanced in the presence of chitosan. These findings indicate that the plain P scaffold provided a good 3D-matrix for ASC proliferation whereas the addition of chitosan to the PLA96/4 scaffold induced chondrogenic differentiation independent of the medium. Accordingly, a PLA96/4 scaffold modified by chitosan could provide a functional and bioactive basis for tissue-engineered chondral implants.

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MoE publication type: A1 Journal article-refereed
Organisations: Department of Biomedical Engineering, Integrated Technologies for Tissue Engineering Research (ITTE)
Contributors: Ahtiainen, K., Sippola, L., Nurminen, M., Mannerström, B., Haimi, S., Suuronen, R., Hyttinen, J., Ylikomi, T., Kellomäki, M., Miettinen, S.
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Keywords: Adipose stem cell, Bioactive glass, Chitosan, Chondrogenesis, Polylactide, Scaffold, Tissue engineering
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Contribution: organisation=bme,FACT1=1
Publisher name: John Wiley & Sons, Inc.
Source: researchoutputwizard
Source ID: 3820
Research output: Contribution to journal › Article › Scientific › peer-review

Non-intersecting leaf insertion algorithm for tree structure models

We present an algorithm and an implementation to insert broadleaves or needleleaves into a quantitative structure model according to an arbitrary distribution, and a data structure to store the required information efficiently. A structure model contains the geometry and branching structure of a tree. The purpose of this work is to offer a tool for making more realistic simulations of tree models with leaves, particularly for tree models developed from terrestrial laser scanning (TLS) measurements. We demonstrate leaf insertion using cylinder-based structure models, but the associated software implementation is written in a way that enables the easy use of other types of structure models. Distributions controlling

leaf location, size and angles as well as the shape of individual leaves are user definable, allowing any type of distribution. The leaf generation process consist of two stages, the first of which generates individual leaf geometry following the input distributions, while in the other stage intersections are prevented by carrying out transformations when required. Initial testing was carried out on English oak trees to demonstrate the approach and to assess the required computational resources. Depending on the size and complexity of the tree, leaf generation takes between 6 and 18 min. Various leaf area density distributions were defined, and the resulting leaf covers were compared with manual leaf harvesting measurements. The results are not conclusive, but they show great potential for the method. In the future, if our method is demonstrated to work well for TLS data from multiple tree types, the approach is likely to be very useful for three-dimensional structure and radiative transfer simulation applications, including remote sensing, ecology and forestry, among others.

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MoE publication type: A1 Journal article-refereed
Organisations: Mathematics, Forest Research, Department of Applied Health Research, NERC National Centre for Earth Observation (NCEO), University of Salford, Newcastle University, United Kingdom, York St John University
Contributors: Åkerblom, M., Raumonen, P., Casella, E., Disney, M. I., Danson, F. M., Gaulton, R., Schofield, L. A., Kaasalainen, M.
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Journal: Interface Focus
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ASJC Scopus subject areas: Biotechnology, Biophysics, Bioengineering, Biochemistry, Biomaterials, Biomedical Engineering
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http://urn.fi/URN:NBN:fi:tty-201804061461
Source: Scopus
Source ID: 85043466694
Research output: Contribution to journal › Article › Scientific › peer-review

Strontium- and calcium-containing, titanium-stabilised phosphate-based glasses with prolonged degradation for orthopaedic tissue engineering

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Research group: Biomaterials and Tissue Engineering Group, BioMediTech, Integrated Technologies for Tissue Engineering Research (ITTE), BioMediTech - Institute of Biosciences and Medical Technology, Adult Stem Cell Group, CREST - University College London, Division of Biomaterials and Tissue Engineering, UCL Eastman Dental Institute, Faculty of Mathematical and Physical Sciences, Department of Nanobiomedical Science, BK21 Plus NBM Global Research Center for Regenerative Medicine, Dankook University, Institute of Tissue Regeneration Engineering, College of Dentistry, Unit of Orthodontics, Department of Craniofacial Growth and Development
Contributors: Al Qaysi, M., Walters, N. J., Foroutan, F., Owens, G. J., Kim, H. W., Shah, R., Knowles, J. C.
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ISSN (Print): 0885-3282
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Original language: English
ASJC Scopus subject areas: Biomedical Engineering, Biomaterials
Keywords: biomaterial, calcium, Phosphate-based glass, strontium, tissue engineering
DOIs:

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Research output: Contribution to journal › Article › Scientific › peer-review

Analysis of biomaterial scaffold fiber thickness for assessing cell attachment

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Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Department of Biomedical Engineering, Integrated Technologies for Tissue Engineering Research (ITTE)
Contributors: Aydogan, D. B., Hannula, M., Rajala, A., Pälli, A., Haimi, S., Kellomäki, M., Hyttinen, J.
Publication date: 2011

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Title of host publication: 24th European Conference on Biomaterials - Annual Conference of the European Society for Biomaterials, ESB 2011
ASJC Scopus subject areas: Biomaterials
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Source: Scopus
Source ID: 84887003275
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Compatibilization of natural rubber/nitrile rubber blends by sol–gel nano-silica generated by in situ method
Abstract: Controlled growth of in situ silica, into natural rubber (NR)/nitrile rubber (NBR) blend (40/60 composition by weight) following solution sol–gel method, results in a coherent blend morphology with enhanced composite properties. Similar composites, i.e., in situ silica-filled NR/NBR blend (40/60 by weight), showed better mechanical properties than any other composition that were prepared by soaking sol–gel method in earlier study. However, silica content in the rubber blend was limited to 20 phr (parts per hundred parts of rubber) and could not be increased under experimental condition following soaking sol–gel method. In the present work, silica content is increased (up to 30 phr) beyond that limit for the same blend composition. Accordingly, mechanical properties of the NR/NBR composites are improved. Use of a silane coupling agent, viz., bis-(3-triethoxysilylpropyl)-tetra sulfide, in the reactive sol–gel system during in situ silica generation brings in remarkable effect in silica distribution, rubber–filler interaction and mechanical properties of the composites. TEM micrographs of the selected composites reveal that silica is mostly grown at the interfacial region, when silane is used in particular. This results in further enhancement in mechanical properties and compatibility of the blend at the same silica content as evident from stress–strain and dynamic mechanical analysis studies. The reinforcement of effect in situ silica is assessed by Guth–Gold equation and modified form of Guth equation (with shape factor f = 2.53). The results are supported by the detailed studies on rheological, morphological, mechanical and viscoelastic properties of the composites.
Graphical Abstract: [Figure not available: see fulltext.]

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Materials Science, Visvesvaraya National Institute of Technology, Indian Rubber Manufacturers Research Association, Department of Elastomers, Leibniz-Institut für Polymerforschung Dresden E.V., University of Kalyani
Contributors: Bansod, N. D., Kapgate, B. P., Das, C., Das, A., Basu, D., Debnath, S. C.
Number of pages: 12
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Journal: JOURNAL OF SOL-GEL SCIENCE AND TECHNOLOGY

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Original language: English
ASJC Scopus subject areas: Chemistry(all), Condensed Matter Physics, Biomaterials, Ceramics and Composites, Electronic, Optical and Magnetic Materials, Materials Chemistry
Keywords: In situ silica, Reinforcement, Rubber blend, Rubber–filler interaction, Silane treatment, Sol–gel method
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Source: Scopus
Source ID: 84974817789
Research output: Contribution to journal › Article › Scientific › peer-review

Soft graphoepitaxy for large area directed self-assembly of polystyrene-block-poly(dimethylsiloxane) block copolymer on nanopatterned poss substrates fabricated by nanoimprint lithography

Polyhedral oligomeric silsequioxane (POSS) derivatives have been successfully employed as substrates for graphoepitaxial directed self-assembly (DSA) of block copolymers (BCPs). Tailored POSS materials of tuned surface chemistry are subject to nanoimprint lithography (NIL) resulting in topographically patterned substrates with dimensions commensurate with the BCP block length. A cylinder forming polystyrene-block-polydimethylsiloxane (PS-b-PDMS) BCP is synthesized by sequential living anionic polymerization of styrene and hexamethylcyclotrisiloxane. The patterned POSS materials provide a surface chemistry and topography for DSA of this BCP and after solvent annealing the BCP shows well-ordered microphase segregation. The orientation of the PDMS cylinders to the substrate plane could be controlled within the trench walls by the choice of the POSS materials. The BCP patterns are successfully used as on-chip etch mask to transfer the pattern to underlying silicon substrate. This soft graphoepitaxy method shows highly promising results as a means to generate lithographic quality patterns by nonconventional methods and could be applied to both hard and soft substrates. The methodology might have application in several fields including device and interconnect fabrication, nanoimprint lithography stamp production, nanofluidic devices, lab-on-chip, or in other technologies requiring simple nanodimensional patterns. A methodology for fabricating highly ordered silicon nanostructures at a substrate is reported using nanoimprint lithography imprinted polyhedral oligomeric silsequioxane (POSS) substrates for graphoepitaxial directed self-assembly (DSA) of block copolymer (BCP). The patterned POSS materials provide a surface chemistry and topography for DSA of a cylinder forming polystyrene-block-polydimethylsiloxane BCP with well-ordered microphase segregation upon solvent annealing.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Frontier Photonics, Trinity College Dublin, University College Cork, Tyndall National Institute at National University of Ireland, Cork, Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN), Laboratoire des Technologies de la Microelectronique (CNRS), Profactor GmbH, University Campus-Dourouti
Contributors: Borah, D., Rasappa, S., Salaun, M., Zellsman, M., Lorret, O., Liontos, G., Ntetsikas, K., Avgeropoulos, A., Morris, M. A.
Number of pages: 8
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Publication information

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Scopus rating (2015): CiteScore 20.4 SJR 4.859 SNIP 2.439
Original language: English
ASJC Scopus subject areas: Electronic, Optical and Magnetic Materials, Biomaterials, Condensed Matter Physics, Electrochemistry
Keywords: block copolymer, directed self-assembly, nanoimprint lithography, pattern transfer, polyhedral oligomeric silsequioxane (POSS)
DOIs:

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Research output: Contribution to journal › Article › Scientific › peer-review

The sensitivity of random polymer brush-lamellar polystyrene-b-polymethylmethacrylate block copolymer systems to process conditions

The use of random copolymer brushes (polystyrene- r-polymethylmethacrylate - PS- r-PMMA) to 'neutralise' substrate surfaces and ordain perpendicular orientation of the microphase separated lamellae in symmetric polystyrene- b-polymethylmethacrylate (PS- b-PMMA) block copolymers (BCPs) is well known. However, less well known is how the brushes interact with both the substrate and the BCP, and how this might change during thermal processing. A detailed study of changes in these films for different brush and diblock PS- b-PMMA molecular weights is reported here. In general, self-assembly and pattern formation is altered little, and a range of brush molecular weights are seen to be effective. However, on extended anneal times, the microphase separated films can undergo dimension changes and loss of order. This process is not related to any complex microphase separation dynamics but rather a degradation of methacrylate components in the film. The data suggest that care must be taken in interpretation of structural changes in these systems as being due to BCP only effects.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Frontier Photonics, Tyndall National Institute at National University of Ireland, Cork, Materials Chemistry and Analysis Group, University College Cork, Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN), Trinity College Dublin, Leixlip Co.
Contributors: Borah, D., Rasappa, S., Senthamaraikannan, R., Shaw, M. T., Holmes, J. D., Morris, M. A.
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Issue number: 1
ISSN (Print): 0021-9797
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Original language: English
ASJC Scopus subject areas: Electronic, Optical and Magnetic Materials, Biomaterials, Surfaces, Coatings and Films, Colloid and Surface Chemistry
Keywords: Microphase separation, Polymer brush, Polystyrene-b-polymethylmethacrylate, Polystyrene-r-polymethylmethacrylate, Surface morphology
DOIs:

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Source: Scopus
Source ID: 84873060382
Research output: Contribution to journal › Article › Scientific › peer-review

Pipeline for effective denoising of digital mammography and digital breast tomosynthesis

Denoising can be used as a tool to enhance image quality and enforce low radiation doses in X-ray medical imaging. The effectiveness of denoising techniques relies on the validity of the underlying noise model. In full-field digital mammography (FFDM) and digital breast tomosynthesis (DBT), calibration steps like the detector offset and flat-fielding can affect some assumptions made by most denoising techniques. Furthermore, quantum noise found in X-ray images is signal-dependent and can only be treated by specific filters. In this work we propose a pipeline for FFDM and DBT image denoising that considers the calibration steps and simplifies the modeling of the noise statistics through variance-stabilizing transformations (VST). The performance of a state-of-the-art denoising method was tested with and without the proposed pipeline. To evaluate the method, objective metrics such as the normalized root mean square error (N-RMSE), noise power spectrum, modulation transfer function (MTF) and the frequency signal-to-noise ratio (SNR) were analyzed. Preliminary tests show that the pipeline improves denoising. When the pipeline is not used, bright pixels of the denoised image are under-filtered and dark pixels are over-smoothed due to the assumption of a signal-independent Gaussian model. The pipeline improved denoising up to 20% in terms of spatial N-RMSE and up to 15% in terms of frequency SNR. Besides improving the denoising, the pipeline does not increase signal smoothing significantly, as shown by the MTF. Thus, the proposed pipeline can be used with state-of-the-art denoising techniques to improve the quality of DBT and FFDM images.

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MoE publication type: A4 Article in a conference publication
Organisations: Signal Processing, University of São Paulo, University of Pennsylvania
Contributors: Borges, L. R., Bakic, P. R., Foi, A., Maidment, A. D., Vieira, M. A.
Publication date: 2017

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ASJC Scopus subject areas: Electronic, Optical and Magnetic Materials, Atomic and Molecular Physics, and Optics, Biomaterials, Radiology Nuclear Medicine and imaging
Keywords: Denoising, Digital breast tomosynthesis, Full field digital mammography, Variance stabilization
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Source: Scopus
Source ID: 85020415748
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Lead field theory provides a powerful tool for designing microelectrode array impedance measurements for biological cell detection and observation
Background: Our aim is to introduce a method to enhance the design process of microelectrode array (MEA) based electric bioimpedance measurement systems for improved detection and viability assessment of living cells and tissues. We propose the application of electromagnetic lead field theory and reciprocity for MEA design and measurement result interpretation. Further, we simulated impedance spectroscopy (IS) with two- and four-electrode setups and a biological cell to illustrate the tool in the assessment of the capabilities of given MEA electrode constellations for detecting cells on or in the vicinity of the microelectrodes. Results: The results show the power of the lead field theory in electromagnetic simulations of cell-microelectrode systems depicting the fundamental differences of two- and four-electrode IS measurement configurations to detect cells. Accordingly, the use in MEA system design is demonstrated by assessing the differences between the two- and four-electrode IS configurations. Further, our results show how cells affect the lead fields in these MEA system, and how we can utilize the differences of the two- and four-electrode setups in cell detection. The COMSOL simulator model is provided freely in public domain as open source. Conclusions: Lead field theory can be successfully applied in MEA design for the IS based assessment of biological cells providing the necessary visualization and insight for MEA design. The proposed method is expected to enhance the design and usability of automated cell and tissue manipulation systems required for bioreactors, which are intended for the automated production of cell and tissue grafts for medical purposes. MEA systems are also intended for toxicology to assess the effects of chemicals on living cells. Our results demonstrate that lead field concept is expected to enhance also the development of such methods and devices.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Faculty of Biomedical Sciences and Engineering, Research group: Computational Biophysics and Imaging Group, BioMediTech, Institute of Biomedical Engineering and Informatics
Contributors: Böttrich, M., Tanskanen, J. M., Hyttinen, J. A.
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Article number: 85
ISSN (Print): 1475-925X
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Scopus rating (2017): CiteScore 3.6 SJR 0.542 SNIP 1.027
Original language: English
ASJC Scopus subject areas: Radiological and Ultrasound Technology, Biomaterials, Biomedical Engineering, Radiology Nuclear Medicine and imaging
Keywords: Bioimpedance, Biological cells, Finite element analysis, Impedance spectroscopy, Microelectrodes, Sensor arrays
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Source ID: 85021204612
Research output: Contribution to journal › Article › Scientific › peer-review

Honeycomb porous films as permeable scaffold materials for human embryonic stem cell-derived retinal pigment epithelium

Age-related macular degeneration (AMD) is a leading cause of blindness in developed countries, characterised by the degeneration of the retinal pigment epithelium (RPE), a pigmented cell monolayer that closely interacts with the photoreceptors. RPE transplantation is thus considered a very promising therapeutic option to treat this disease. In this work, porous honeycomb-like films are for the first time investigated as scaffold materials for human embryonic stem cell-derived retinal pigment epithelium (hESC-RPE). By changing the conditions during film preparation, it was possible to produce films with homogeneous pore distribution and adequate pore size (3-5 μm), that is large enough to ensure high permeability but small enough to enable cell adherence and spreading. A brief dip-coating procedure with collagen type IV enabled the homogeneous adsorption of the protein to the walls and bottom of pores, increasing the hydrophilicity of the surface. hESC-RPE adhered and proliferated on all the collagen-coated materials, regardless of small differences in pore size. The differentiation of hESC-RPE was confirmed by the detection of specific RPE protein markers. These results suggest that the porous honeycomb films can be promising candidates for hESC-RPE tissue engineering, importantly enabling the free flow of ions and molecules across the material.

General information

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Organisations: BioMediTech, Department of Electronics and Communications Engineering, Research group: Biomaterials and Tissue Engineering Group
Contributors: Calejo, M. T., Ilmarinen, T., Jongprasitkul, H., Skottman, H., Kellomäki, M.
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Original language: English
ASJC Scopus subject areas: Ceramics and Composites, Biomaterials, Biomedical Engineering, Metals and Alloys
Keywords: honeycomb films, permeability, pluripotent stem cells, retinal pigment epithelium, tissue engineering
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HA composites of segmented polyurethanes prepared with glutamine or ascorbic acid as chain extenders for bone tissue regeneration

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Organisations: Integrated Technologies for Tissue Engineering Research (ITTE), Centro de Investigación Científica de Yucatán A.C, BME Dept.
Contributors: Cetina-Diaz, S. M., Vargas-Coronado, R. F., Cervantes-Uc, J. M., Cauich-Rodríguez, J. V., Ahola, N., Paakinaho, K., Kellomaki, M.
Publication date: 2011

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ASJC Scopus subject areas: Biomaterials
URLs:

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Source: Scopus
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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Development of a new illumination procedure for photodynamic therapy of the abdominal cavity
A homogeneous illumination of intra-abdominal organs is essential for successful photodynamic therapy of the abdominal cavity. Considering the current lack of outstanding light-delivery systems, a new illumination procedure was assessed. A rat model of peritoneal carcinomatosis was used. Four hours after intraperitoneal injection of hexaminolevulinate, a square illuminating panel connected to a 635-nm laser source was inserted vertically into the abdominal cavity. The abdominal incision was sutured and a pneumoperitoneum created prior to illumination. Light dosimetry was based on the calculation of the peritoneal surface by MRI. The rats were treated with a light dose of 20,10, 5 or 2.5 J/cm^2 administered continuously with an irradiance of 7 mW/cm ^{2}. The homogeneity of the cavity illumination was assessed by quantification of the photobleaching of the tumor lesions according to their localization and by scoring of that of the liver and of the bowel immediately after treatment. Photobleaching quantification for tumor lesions relied on the calculation of the fluorescence intensity ratio (after/before treatment) after recording of the lesions during blue-light laparoscopy and determination of their fluorescence intensity with Sigmascan Pro software. The procedure led to a homogeneous treatment of the abdominal cavity. No statistical difference was observed for the photobleaching values according to the localization of the lesions on the peritoneum ($p = 0.59$) and photobleaching of the liver and of the intestine was homogeneous. We conclude that this procedure can successfully treat the major sites involved in peritoneal carcinomatosis.

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Organisations: Frontier Photonics, Lille University Hospital - CHRU, Univ Lille Nord de France, GDR 3049
Contributors: Cuyon, L., Lesage, J. C., Betrouni, N., Mordon, S.
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Research output: Contribution to journal › Article › Scientific › peer-review

Osteoconductive properties of poly(96L/4D-lactide)/beta-tricalcium phosphate in long term animal model

The objective of this study was to determine the effect of calcium phosphate mineral content on the bone in-growth at the expense of composite of co-polylactide polymer charged with 2 different ratios of β-TCP granules (10 and 24 w-% of β-TCP). The evaluation was realized in a long term rabbit bone model. After 24, 48 and 76 weeks, the implants were examined by micro CT, scanning electron microscopy (SEM) using backscattered electron (BSE) and light microscopy (polarized and blue light microscopy). No foreign body reaction was detected during the 76 weeks follow-up in any of the test samples. Polymer hydrolysis began at approximately 24 weeks, by 76 weeks, the pure polymer implant had begun to release P(96L/4D)LA particles and show signs of peripheral localized bone resorption. A decrease in the amount of CaP was noticed between 24 and 76 weeks in both 10 wt-% and 24 wt-% β-TCP/P(96L/4D)LA composites. The study showed that the highest bone in-growth was with 24 wt-% β-TCP/P(96L/4D)LA composite. Bone in-growth and mineralization were evident for the composites associated with specific peripheral bone architecture. Fluorescent labelling demonstrated high bone in-growth and remodeling at the interface, while for pure co-polymer no bone remodeling or bone activity was maintained after 48 weeks. The study demonstrated the positive effect of calcium phosphate content into P(96L/4D)LA. This kind of composite is a suitable resorbable osteoconductive matrix, which provides long term stability required for ligament fixation device.

General information

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Organisations: Engineering materials science and solutions (EMASS), PTIB Hôpital Xavier Arnozan, National Veterinary School of Nantes, Conmed Linvatec Biomaterials Ltd.
Contributors: Daculsi, G., Goyenvalle, E., Cognet, R., Aguado, E., Suokas, E. O.
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Keywords: Bone regeneration, Co-polylactide/beta-tricalcium phosphate, Composite, Long term study
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Research output: Contribution to journal › Article › Scientific › peer-review

Hollow fibers of poly(lactide-co-glycolide) and poly(ε-caprolactone) blends for vascular tissue engineering applications

At present the manufacture of small-diameter blood vessels is one of the main challenges in the field of vascular tissue engineering. Currently available vascular grafts rapidly fail due to development of intimal hyperplasia and thrombus formation. Poly(lactic-co-glycolic acid) (PLGA) hollow fiber (HF) membranes have previously been proposed for this application, but as we show in the present work, they have an inhibiting effect on cell proliferation and rather poor mechanical properties. To overcome this we prepared HF membranes via phase inversion using blends of PLGA with poly(ε-caprolactone) (PCL). The influence of polymer composition on the HF physicochemical properties (topography, water transport and mechanical properties) and cell attachment and proliferation were studied. Our results show that only the ratio PCL/PLGA of 85/15 (PCL/PLGA85/15) yielded a miscible blend after processing. A higher PLGA concentration in the blend led to immiscible PCL/PLGA phase-separated HFs with an inhomogeneous morphology and variation in the cell culture results. In fact, the PCL/PLGA85/15 blend, which had the most homogeneous morphology and suitable pore structure, showed better human adipose stem cell (hASC) attachment and proliferation compared with the homopolymers. This, combined with the good mechanical and transport properties, makes them potentially useful for the development of small-caliber vascular grafts.

General information

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Organisations: Integrated Technologies for Tissue Engineering Research (ITTE), University of Cantabria, University of Twente, BioMediTech, University of Groningen

Contributors: Diban, N., Haimi, S., Bolhuis-Versteeg, L., Teixeira, S., Miettinen, S., Poot, A., Grijpma, D., Stamatialis, D.
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Research output: Contribution to journal › Article › Scientific › peer-review

Weighing trees with lasers: Advances, challenges and opportunities
Terrestrial laser scanning (TLS) is providing exciting new ways to quantify tree and forest structure, particularly above-ground biomass (AGB). We show how TLS can address some of the key uncertainties and limitations of current approaches to estimating AGB based on empirical allometric scaling equations (ASEs) that underpin all large-scale estimates of AGB. TLS provides extremely detailed non-destructive measurements of tree form independent of tree size and shape. We show examples of three-dimensional (3D) TLS measurements from various tropical and temperate forests and describe how the resulting TLS point clouds can be used to produce quantitative 3D models of branch and trunk size, shape and distribution. These models can drastically improve estimates of AGB, provide new, improved large-scale ASEs, and deliver insights into a range of fundamental tree properties related to structure. Large quantities of detailed measurements of individual 3D tree structure also have the potential to open new and exciting avenues of research in areas where difficulties of measurement have until now prevented statistical approaches to detecting and understanding underlying patterns of scaling, form and function. We discuss these opportunities and some of the challenges that remain to be overcome to enable wider adoption of TLS methods.

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Organisations: Mathematics, Department of Applied Health Research, NERC National Centre for Earth Observation (NCEO), National Physical Laboratory, Universiteit Gent, School of Geography, University of Leeds
Contributors: Disney, M. I., Boni Vicari, M., Burt, A., Calders, K., Lewis, S. L., Raumonen, P., Wilkes, P.
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EXT="Lewis, S. L."
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Research output: Contribution to journal › Article › Scientific › peer-review

Effect of melt-derived bioactive glass particles on the properties of chitosan scaffolds
This study reports on the processing of three-dimensional (3D) chitosan/bioactive glass composite scaffolds. On the one hand, chitosan, as a natural polymer, has suitable properties for tissue engineering applications but lacks bioactivity. On the other hand, bioactive glasses are known to be bioactive and to promote a higher level of bone formation than any other biomaterial type. However, bioactive glasses are hard, brittle, and cannot be shaped easily. Therefore, in the past years, researchers have focused on the processing of new composites. Difficulties in reaching composite materials made of polymer (synthetic or natural) and bioactive glass include: (i) The high glass density, often resulting in glass segregation, and (ii) the fast bioactive glass reaction when exposed to moisture, leading to changes in the glass reactivity and/or change in the polymeric matrix. Samples were prepared with 5, 15, and 30 wt% of bioactive glass S53P4 (BonAlive®), as confirmed using thermogravimetric analysis. MicrO–Computed tomography and optical microscopy revealed a flaky structure with porosity over 80%. The pore size decreased when increasing the glass content up to 15 wt%, but increased back when the glass content was 30 wt%. Similarly, the mechanical properties (in compression) of the scaffolds increased for glass content up to 15%, but decreased at higher loading. Ions released from the scaffolds were found to lead to precipitation of a calcium phosphate reactive layer at the scaffold surface. This is a first indication of the potential bioactivity of these materials. Overall, chitosan/bioactive glass composite scaffolds were successfully produced with pore size, machinability, and ability to promote a calcium phosphate layer, showing promise for bone tissue engineering and the mechanical properties can justify their use in non-load bearing applications.

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Contributors: Faqhiri, H., Hannula, M., Kellomäki, M., Calejo, M. T., Massera, J.
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Azopolymer photopatterning for directional control of angiogenesis
Understanding cellular behavior in response to microenvironmental stimuli is central to tissue engineering. An increasing number of reports emphasize the high sensitivity of cells to the physical characteristics of the surrounding milieu and in particular, topographical cues. In this work, we investigated the influence of dynamic topographic signal presentation on sprout formation and the possibility to obtain a space–time control over sprouting directionality without growth factors, in order to investigate the contribution of just topography in the angiogenic process. To test our hypothesis, we employed a

3D angiogenesis assay based on the use of spheroids derived from human umbilical vein endothelial cells (HUVECs). We then modulated the in situ presentation of topographical cues during early-stage angiogenesis through real-time photopatterning of an azobenzene-containing polymer, poly (Disperse Red 1 methacrylate) (pDR1m). Pattern inscription on the polymer surface was made using the focused laser of a confocal microscope. We demonstrate that during early-stage angiogenesis, sprouts followed the pattern direction, while spheroid cores acquired a polarized shape. These findings confirmed that sprout directionality was influenced by the photo-inscribed pattern, probably through contact guidance of leader cells, thus validating the proposed platform as a valuable tool for understanding complex processes involved in cell-topography interactions in multicellular systems. Statement of Significance The complex relationship between endothelial cells and the surrounding environment that leads to formation of a newly formed vascular network during tissue repair is currently unknown. We have developed an innovative in vitro platform to study these mechanisms in a space and time controlled fashion simulating what happens during regeneration. In particular, we combine a “smart” surface, namely a polymer film, with a three-dimensional living cell aggregate. The polymer is activated by light through which we can design a path to guide cells toward the formation of a new vessel. Our work lies at the intersection of stimuli-responsive biointerfaces and cell biology and may be particularly inspiring for those interested in designing biomaterial surface related to angiogenesis.

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Contributors: Fedele, C., De Gregorio, M., Netti, P. A., Cavalli, S., Attanasio, C.
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Structure and Dynamics of Thermosensitive pDNA Polyplexes Studied by Time-Resolved Fluorescence Spectroscopy

Combining multiple stimuli-responsive functionalities into the polymer design is an attractive approach to improve nucleic acid delivery. However, more in-depth fundamental understanding how the multiple functionalities in the polymer structures are influencing polyplex formation and stability is essential for the rational development of such delivery systems. Therefore, in this study the structure and dynamics of thermosensitive polyplexes were investigated by tracking the behavior of labeled plasmid DNA (pDNA) and polymer with time-resolved fluorescence spectroscopy using fluorescence resonance energy transfer (FRET). The successful synthesis of a heterofunctional poly(ethylene glycol) (PEG) macroinitiator containing both an atom transfer radical polymerization (ATRP) and reversible addition-fragmentation chain-transfer (RAFT) initiator is reported. The use of this novel PEG macroinitiator allows for the controlled polymerization of cationic and thermosensitive linear triblock copolymers and labeling of the chain-end with a fluorescent dye by maleimide-thiol chemistry. The polymers consisted of a thermosensitive poly(N-isopropylacrylamide) (PNIPAM, N), hydrophilic PEG (P), and cationic poly(2-(dimethylamino)ethyl methacrylate) (PDMAEMA, D) block, further referred to as NPD. Polymer block D chain-ends were labeled with Cy3, while pDNA was labeled with FITC. The thermosensitive NPD polymers were used to prepare pDNA polyplexes, and the effect of the N/P charge ratio, temperature, and composition of the triblock copolymer on the polyplex properties were investigated, taking nonthermosensitive PD polymers as the control. FRET was observed both at 4 and 37 °C, indicating that the introduction of the thermosensitive PNIPAM block did not compromise the polyplex structure even above the polymer's cloud point. Furthermore, FRET results showed that the NPD- and PD-based polyplexes have a less dense core compared to polyplexes based on cationic homopolymers (such as PEI) as reported before. The polyplexes showed to have a dynamic character meaning that the polymer chains can exchange between the polyplex core and shell. Mobility of the polymers allow their uniform redistribution within the polyplex and this feature has been reported to be favorable in the context of pDNA release and subsequent improved transfection efficiency, compared to nondynamic formulations.

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Organisations: Materials Science and Environmental Engineering, Research group: Chemistry & Advanced Materials, Utrecht University, Helsinki University, Chemistry and Advanced Materials
Contributors: Fliervoet, L. A., Lisitsyna, E. S., Durandin, N. A., Kotsis, I., Maas-Bakker, R. F., Yliperttula, M., Hennink, W. E., Vuorimaa-Laukkanen, E., Vermonden, T.
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Sol-gel synthesis of quaternary (P2O5)55-(CaO)25-(Na2O)(20-x)-(TiO2) x bioresorbable glasses for bone tissue engineering applications (x = 0, 5, 10, or 15)
In the present study, we report a new and facile sol-gel synthesis of phosphate-based glasses with the general formula of (P2O5)55-(CaO)25-(Na2O)(20-x)-(TiO2) x , where x = 0, 5, 10 or 15, for bone tissue engineering applications. The sol-gel synthesis method allows greater control over glass morphology at relatively low processing temperature (200 °C) in comparison with phosphate-based melt-derived glasses (~1000 °C). The glasses were analyzed using several characterization techniques, including x-ray diffraction (XRD), (31)P magic angle spinning nuclear magnetic resonance ((31)P MAS-NMR), Fourier transform infrared (FTIR) spectroscopy and energy-dispersive x-ray (EDX) spectroscopy, which confirmed the amorphous and glassy nature of the prepared samples. Degradation was assessed by measuring the ion release and pH change of the storage medium. Cytocompatibility was also confirmed by culturing osteoblast-like osteosarcoma cell line MG-63 on the glass microparticles over a seven-day period. Cell attachment to the particles was imaged using scanning electron microscopy (SEM) and confocal laser scanning microscopy (CLSM). The results revealed the potential of phosphate-based sol-gel derived glasses containing 5 or 10 mol% TiO2, with high surface area, ideal dissolution rate for cell attachment and easily metabolized dissolution products, for bone tissue engineering applications.

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Organisations: Integrated Technologies for Tissue Engineering Research (ITTE), UCL Eastman Dental Institute
Contributors: Foroutan, F., Walters, N. J., Owens, G. J., Mordan, N. J., Kim, H. W., de Leeuw, N. H., Knowles, J. C.
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On the limit of superhydrophobicity: Defining the minimum amount of TiO_2 nanoparticle coating

Fabrication of superhydrophobic surfaces in large scale has been in high interest for several years, also titanium oxide nanostructures having been applied for the purpose. Optimizing the amount and structure of the TiO_2 material in the coating will play a key role when considering upscaling. Here, we take a look at fabricating the superhydrophobic surface in a one-step roll-to-roll pilot scale process by depositing TiO_2 nanoparticles from a Liquid Flame Spray onto a moving paperboard substrate. In order to find the minimum amount of nanomaterial still sufficient for creating superhydrophobicity, we varied nanoparticle production rate, flame distance from the substrate and line speed. Since the deposited amount of material sideways from the flame path was seen to decrease gradually, spatial analysis enabled us to consistently determine the minimum amount of TiO_2 nanoparticles on the substrate needed to achieve superhydrophobicity. Amount as low as 20-30 mg m^{-2} of TiO_2 nanoparticles was observed to be sufficient. The scanning electron microscopy revealed that at this amount, the surface was covered with nanoparticles only partially, but still sufficiently to create a hierarchical structure to affect wetting significantly. Based on XPS analysis, it became apparent that TiO_2 gathers hydrocarbons on the surface to develop the surface chemistry towards hydrophobic, but below the critical amount of TiO_2 nanoparticles, the chemistry could not enable superhydrophobicity anymore. While varying the deposited amount of TiO_2, besides the local spatial variance of the coating amount, also the overall yield was studied. Within the text matrix, a yield up to 44% was achieved. In conclusion, superhydrophobicity was achieved at all tested line speeds (50 to 300 m min^{-1}), even if the amount of TiO_2 varied significantly (20 to 230 mg m^{-2}).

General information

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Organisations: Physics, Research group: Aerosol Synthesis, Research area: Aerosol Physics, Materials Science, Packaging Technology Research Team, Physics at Interfaces, Max Planck Institute for Polymer Research, Bioscience and Materials/Surface, RISE Research Institutes of Sweden AB, Finnish Environment Institute, Abo Akad Univ, Abo Akademi University, Dept Phys, AGH University of Science and Technology, University of Eastern Finland
Contributors: Haapanen, J., Aromaa, M., Teisala, H., Juuti, P., Tuominen, M., Sillanpää, M., Stepien, M., Saarinen, J. J., Toivakka, M., Kuusipalo, J., Mäkelä, J. M.
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Transcription closed and open complex formation coordinate expression of genes with a shared promoter region

Many genes are spaced closely, allowing coordination without explicit control through shared regulatory elements and molecular interactions. We study the dynamics of a stochastic model of a gene-pair in a head-to-head configuration, sharing promoter elements, which accounts for the rate-limiting steps in transcription initiation. We find that only in specific regions of the parameter space of the rate-limiting steps is orderly coexpression exhibited, suggesting that successful cooperation between closely spaced genes requires the coevolution of compatible rate-limiting step configuration. The model predictions are validated using in vivo single-cell, single-RNA measurements of the dynamics of pairs of genes sharing promoter elements. Our results suggest that, in E. coli, the kinetics of the rate-limiting steps in active transcription can play a central role in shaping the dynamics of gene-pairs sharing promoter elements.

General information

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Contributors: Häkkinen, A., Oliveira, S. M., Neeli-Venkata, R., Ribeiro, A. S.
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Cell adhesion and culture medium dependent changes in the high frequency mechanical vibration induced proliferation, osteogenesis, and intracellular organization of human adipose stem cells
High frequency (HF) mechanical vibration appears beneficial for in vitro osteogenesis of mesenchymal stem cells (MSCs). However, the current mechanobiological understanding of the method remains insufficient. We designed high-throughput stimulators to apply horizontal or vertical high magnitude HF (HMHF; 2.5 G_{peak}, 100 Hz) vibration on human adipose stem cells (hASCs). We analyzed proliferation, alkaline phosphatase (ALP) activity, mineralization, and effects on the actin cytoskeleton and nuclei using immunocytochemical stainings. Proliferation was studied on a standard tissue culture plastic (sTCP) surface and on an adhesion supporting tissue culture plastic (asTCP) surface in basal (BM) and osteogenic (OM) culture medium conditions. We discovered that the improved cell adhesion was a prerequisite for vibration induced changes in the proliferation of hASCs. Similarly, the adhesion supporting surface enabled us to observe vibration initiated ALP activity and mineralization changes in OM condition. The horizontal vibration increased ALP activity, while vertical stimulation reduced ALP activity. However, mineralization was not enhanced by the HMHF vibration. We performed image-based analysis of actin and nuclei to obtain novel data of the intracellular-level responses to HF vibration in BM and OM conditions. Our quantitative results suggest that actin organizations were culture medium and stimulation direction dependent. Both stimulation directions decreased OM induced changes in nuclear size and elongation. Consequently, our findings of the nuclear deformations provide supportive evidence for the involvement of the nuclei in the mechanocoupling of HF vibration. Taken together, the results of this study enhanced the knowledge of the intracellular mechanisms of HF vibration induced osteogenesis of MSCs.

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Organisations: Research group: Computational Biophysics and Imaging Group, BioMediTech, Tampere University Hospital
Contributors: Halonen, H. T., Ihalainen, T. O., Hyväri, L., Miettinen, S., Hyttinen, J. A.
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Source: Scopus
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Wetting hysteresis induced by temperature changes: Supercooled water on hydrophobic surfaces
The state and stability of supercooled water on (super)hydrophobic surfaces is crucial for low temperature applications and it will affect anti-icing and de-icing properties. Surface characteristics such as topography and chemistry are expected to affect wetting hysteresis during temperature cycling experiments, and also the freezing delay of supercooled water. We utilized stochastically rough wood surfaces that were further modified to render them hydrophobic or superhydrophobic. Liquid flame spraying (LFS) was utilized to create a multi-scale roughness by depositing titanium dioxide nanoparticles. The coating was subsequently made non-polar by applying a thin plasma polymer layer. As flat reference samples modified silica surfaces with similar chemistries were utilized. With these substrates we test the hypothesis that superhydrophobic surfaces also should retard ice formation. Wetting hysteresis was evaluated using contact angle measurements during a freeze-thaw cycle from room temperature to freezing occurrence at -7 °C, and then back to room temperature. Further, the delay in freezing of supercooled water droplets was studied at temperatures of -4 °C and -7 °C. The hysteresis in contact angle observed during a cooling-heating cycle is found to be small on flat hydrophobic surfaces. However, significant changes in contact angles during a cooling-heating cycle are observed on the rough surfaces, with a higher contact angle observed on cooling compared to during the subsequent heating. Condensation and subsequent frost formation at sub-zero temperatures induce the hysteresis. The freezing delay data show that the flat surface is more efficient in enhancing the freezing delay than the rougher surfaces, which can be rationalized considering heterogeneous nucleation theory. Thus, our data suggests that molecular flat surfaces, rather than rough superhydrophobic surfaces, are beneficial for retarding ice formation under conditions that allow condensation and frost formation to occur.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Department of Physics, Research area: Aerosol Physics, Research group: Aerosol Synthesis, KTH Royal Institute of Technology, Surface and Corrosion Science, SP Technical Research Institute of Sweden, Department of Civil and Architectural Engineering, Nanostructure Physics
Contributors: Heydari, G., Sedighi Moghaddam, M., Tuominen, M., Fielden, M., Haapanen, J., Mäkelä, J. M., Claesson, P. M.
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Publication information
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Original language: English
ASJC Scopus subject areas: Surfaces, Coatings and Films, Electronic, Optical and Magnetic Materials, Biomaterials, Colloid and Surface Chemistry
Keywords: Contact angle, Hydrophobization, Liquid flame spray (LFS), Morphology, Multi-scale roughness, Plasma polymerization, Supercooled water, Superhydrophobicity, Wetting hysteresis, Wood
DOIs:
10.1016/j.jcis.2016.01.040
Source: Scopus
Source ID: 84955276633
Research output: Contribution to journal › Article › Scientific › peer-review

Uniform and electrically conductive biopolymer-doped polypyrrole coating for fibrous PLA
Three-dimensional, fibrous scaffolds can be easily fabricated from polylactide (PLA) using melt spinning and textile techniques. However, the surface properties of PLA scaffolds are not ideal for tissue engineering purposes. Furthermore, electrically conducting scaffolds are required to deliver electrical stimulation to cells. In this study, uniform, electrically conducting polypyrrole (PPy) coatings were fabricated on biodegradable PLA fibers. Biopolymer dopants-hyaluronic acid (HA) and chondroitin sulfate (CS)-were compared, and a PPy/CS composition was analyzed further. The effect of the oxidative polymerization conditions on the PLA fibers and CS counterion was studied. Furthermore, the initial molecular

weight of CS and its degree of polymerization were determined. Our experiments showed that the molecular weight of CS decreases under oxidizing conditions but that the decay is not significant with the short polymerization process we used. The coating process was transferred to nonwoven PLA fabrics, and the stability of PPy/CS coating was studied during in vitro incubation in phosphate buffer solution at physiological temperature. The conductivity and surface roughness of the coating decayed during the 20-day incubation. The mechanical strength, however, remained at the initial level. Thus, the fabricated structures are suitable for short-term electrical stimulation adequate to promote cell functions in specific cases.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Research group: Biomaterials and Tissue Engineering Group, BioMediTech, VTT Technical Research Centre of Finland
Contributors: Hiltunen, M., Pelto, J., Ellä, V., Kellomäki, M.
Pages: 1721–1729
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Journal of Biomedical Materials Research. Part B: Applied Biomaterials
Volume: 104
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ISSN (Print): 1552-4973
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Scopus rating (2016): CiteScore 5.4 SJR 0.745 SNIP 1.057
Original language: English
ASJC Scopus subject areas: Biomedical Engineering, Biomaterials
Keywords: Coating(s), Scaffolds, Stability, Surface characterization, Tissue engineering
DOIs:

10.1002/jbm.b.33514

Bibliographical note
EXT="Pelto, J."
Source: Scopus
Source ID: 84941100023
Research output: Contribution to journal › Article › Scientific › peer-review

Aligned Poly(ε-caprolactone) Nanofibers Guide the Orientation and Migration of Human Pluripotent Stem Cell-Derived Neurons, Astrocytes, and Oligodendrocyte Precursor Cells In Vitro
Stem cell transplantations for spinal cord injury (SCI) have been studied extensively for the past decade in order to replace the damaged tissue with human pluripotent stem cell (hPSC)-derived neural cells. Transplanted cells may, however, benefit from supporting and guiding structures or scaffolds in order to remain viable and integrate into the host tissue. Biomaterials can be used as supporting scaffolds, as they mimic the characteristics of the natural cellular environment. In this study, hPSC-derived neurons, astrocytes, and oligodendrocyte precursor cells (OPCs) are cultured on aligned poly(ε-caprolactone) nanofiber platforms, which guide cell orientation to resemble that of spinal cord in vivo. All cell types are shown to efficiently spread over the nanofiber platform and orient according to the fiber alignment. Human neurons and astrocytes require extracellular matrix molecule coating for the nanofibers, but OPCs grow on nanofibers without additional treatment. Furthermore, the nanofiber platform is combined with a 3D hydrogel scaffold with controlled thickness, and nanofiber-mediated orientation of hPSC-derived neurons is also demonstrated in a 3D environment. In this work, clinically relevant materials and substrates for nanofibers, fiber coatings, and hydrogel scaffolds are used and combined with cells suitable for developing functional cell grafts for SCI repair.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Materials Science, Research group: Materials Characterization
Contributors: Hyysalo, A., Ristola, M., Joki, T., Honkanen, M., Vippola, M., Narkilahti, S.
Publication date: 2017
Peer-reviewed: Yes
Early online date: 2017

Publication information
Journal: MACROMOLECULAR BIOSCIENCE
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ISSN (Print): 1616-5187
Ratings:
Scopus rating (2017): CiteScore 5.7 SJR 1.017 SNIP 0.776
Original language: English
ASJC Scopus subject areas: Biotechnology, Bioengineering, Biomaterials, Polymers and Plastics, Materials Chemistry
Keywords: 3D environment, Differentiated neural cell, Human pluripotent stem cell, Nanofiber, Orientation
DOIs:
10.1002/mabi.201600517
Source: Scopus
Source ID: 85017192272
Research output: Contribution to journal › Article › Scientific › peer-review

Measuring optical anisotropy in poly(3,4-ethylene dioxythiophene): poly(styrene sulfonate) films with added graphene

Abstract Graphene is a 2D nanomaterial having a great potential for applications in electronics and optoelectronics. Composites of graphene with conducting polymers have shown high performance in practical devices and their solution-processability enables low-cost and high-throughput mass manufacturing using printing techniques. Here we measure the effect of incorporation of graphene into poly(3,4-ethylene dioxythiophene):poly(styrene sulfonate) (PEDOT:PSS) to the optical anisotropy, absorbance and conductivity of the film. Uniaxial anisotropy in PEDOT:PSS films has been thought to be caused by the spin-coating process used in fabrication. We have characterized spray- and spin-coated films using ellipsometry and total internal reflection spectroscopy, the latter especially for films too thick and uneven for ellipsometry, and show that spray-coating, similar to inkjet printing, also produces consistently anisotropic properties even in very thick and uneven films. Possible plasmonic excitations related to graphene are not seen in the films. The optical and electrical anisotropy of graphene/PEDOT:PSS enables routes to high performance devices for electronics, photonics and optoelectronics.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Automation Science and Engineering, Research area: Microsystems, Research area: Measurement Technology and Process Control, Integrated Technologies for Tissue Engineering Research (ITTE), Miktech Oy, University of Jyväskylä
Contributors: Isoniemi, T., Tuukkanen, S., Cameron, D. C., Simonen, J., Toppari, J. J.
Number of pages: 7
Pages: 317-323
Publication date: 9 Jul 2015
Peer-reviewed: Yes

Publication information

Journal: Organic Electronics
Volume: 25
ISSN (Print): 1566-1199
Ratings:
Scopus rating (2015): CiteScore 6.5 SJR 1.135 SNIP 1.071
Original language: English
ASJC Scopus subject areas: Biomaterials, Electronic, Optical and Magnetic Materials, Materials Chemistry, Electrical and Electronic Engineering, Chemistry(all), Condensed Matter Physics
Keywords: PEDOT: PSS, Graphene, Anisotropy, Spectroscopy, Conducting polymer, CARBON-NANOTUBE, ELECTRONICS, OPTOELECTRONICS, CONDUCTIVITY, TRANSPARENT, PHOTONICS, GROWTH, CELLS
Electronic versions:
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DOIs:
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Bibliographical note

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EXT="Simonen, Janne"
Source: Scopus
Source ID: 84936759109
Research output: Contribution to journal › Article › Scientific › peer-review

An architectural understanding of natural sway frequencies in trees

The relationship between form and function in trees is the subject of a longstanding debate in forest ecology and provides the basis for theories concerning forest ecosystem structure and metabolism. Trees interact with the wind in a dynamic manner and exhibit natural sway frequencies and damping processes that are important in understanding wind damage. Tree-wind dynamics are related to tree architecture, but this relationship is not well understood. We present a comprehensive view of natural sway frequencies in trees by compiling a dataset of field measurement spanning conifers and broadleaves, tropical and temperate forests. The field data show that a cantilever beam approximation adequately predicts the fundamental frequency of conifers, but not that of broadleaf trees. We also use structurally detailed tree dynamics simulations to test fundamental assumptions underpinning models of natural frequencies in trees. We model the dynamic properties of greater than 1000 trees using a finite-element approach based on accurate three-dimensional model trees derived from terrestrial laser scanning data. We show that (1) residual variation, the variation not explained by the cantilever beam approximation, in fundamental frequencies of broadleaf trees is driven by their architecture; (2) slender trees behave like a simple pendulum, with a single natural frequency dominating their motion, which makes them vulnerable to wind damage and (3) the presence of leaves decreases both the fundamental frequency and the damping ratio. These findings demonstrate the value of new three-dimensional measurements for understanding wind impacts on trees and suggest new directions for improving our understanding of tree dynamics from conifer plantations to natural forests.

General information

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MoE publication type: A1 Journal article-refereed
Organisations: Computing Sciences, University of Oxford, SCION, University of Connecticut, Delft University of Technology, Wageningen University and Research Centre, University of Massachusetts Amherst, National Parks Board, University of Melbourne, Oregon State University, Universiteit Gent, National Physical Laboratory, University College London, NERC National Centre for Earth Observation (NCEO), 16 Center for International Forestry Research (CIFOR), Swedish University of Agricultural Sciences, INRA
Contributors: Jackson, T., Shenkin, A., Moore, J., Bunce, A., van Emmerik, T., Kane, B., Burcham, D., James, K., Selker, J., Calders, K., Origo, N., Disney, M., Burt, A., Wilkes, P., Raumonen, P., Gonzalez de Tanago Menaca, J., Lau, A., Herold, M., Goodman, R. C., Fourcaud, T., Malhi, Y.
Number of pages: 1
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Publication information

Journal: Journal of the Royal Society. Interface
Volume: 16
Issue number: 155
ISSN (Print): 1742-5689
Ratings:

Scopus rating (2019): CiteScore 5.7 SJR 1.694 SNIP 1.411
Original language: English
ASJC Scopus subject areas: Biotechnology, Biophysics, Bioengineering, Biomaterials, Biochemistry, Biomedical Engineering
Keywords: finite-element analysis, fundamental frequency, natural frequencies, terrestrial laser scanning, tree architecture , wind damage
DOIs:

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Source: Scopus
Source ID: 85067464325
Research output: Contribution to journal › Article › Scientific › peer-review

Uncertainty in multispectral lidar signals caused by incidence angle effects

Multispectral terrestrial laser scanning (TLS) is an emerging technology. Several manufacturers already offer commercial dual or three wavelength airborne laser scanners, while multispectral TLS is still carried out mainly with research instruments. Many of these research efforts have focused on the study of vegetation. The aim of this paper is to study the uncertainty of the measurement of spectral indices of vegetation with multispectral lidar. Using two spectral indices as examples, we find that the uncertainty is due to systematic errors caused by the wavelength dependency of laser incidence angle effects. This finding is empirical, and the error cannot be removed by modelling or instrument modification. The discovery and study of these effects has been enabled by hyperspectral and multispectral TLS, and it has become a subject of active research within the past few years. We summarize the most recent studies on multi-wavelength incidence angle effects and present new results on the effect of specular reflection from the leaf surface, and the surface structure, which have been suggested to play a key role. We also discuss the consequences to the measurement of spectral indices with multispectral TLS, and a possible correction scheme using a synthetic laser footprint.

General information

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MoE publication type: A1 Journal article-refereed
Organisations: Mathematics, Department of Navigation and Positioning, FGI
Contributors: Kaasalainen, S., Åkerblom, M., Nevalainen, O., Hakala, T., Kaasalainen, M.
Publication date: 6 Apr 2018
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Journal: Interface Focus
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Issue number: 2
Article number: 20170033
ISSN (Print): 2042-8898
Ratings:

Scopus rating (2018): CiteScore 5.8 SJR 1.138 SNIP 0.95
Original language: English
ASJC Scopus subject areas: Biotechnology, Biophysics, Bioengineering, Biochemistry, Biomaterials, Biomedical Engineering
Keywords: Hyperspectral, Incidence angle, Laser scanning, Vegetation
Electronic versions:

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Source: Scopus
Source ID: 85043458754
Research output: Contribution to journal › Article › Scientific › peer-review

Miniature CoCr laser welds under cyclic shear: Fatigue evolution and crack growth

Miniature laser welds with the root depth in the range of 50–300 μm represent air-tight joints between the components in medical devices, such as those in implants, growth rods, stents and various prostheses. The current work focuses on the development of a fatigue test specimen and procedure to determine fatigue lives of shear-loaded laser welds. A cobalt-chromium (CoCr) alloy is used as a benchmark case. S–N graphs, damage process, and fracture surfaces are studied by applying x-ray analysis, atomic force microscopy, and scanning electron microscopy both before and after the crack onset. A non-linear material model is fitted for the CoCr alloy to run finite element simulations of the damage and deformation. As a result, two tensile-loaded specimen designs are established and the performance is compared to that of a traditional torque-loaded specimen. The new generation specimens show less variation in the determined fatigue lives due to well-defined crack onset point and, therefore, precise weld seam load during the experiments. The fatigue damage concentrates to the welded material and the entire weld experiences fatigue prior to the final, fracture-governed failure phase. For the studied weld seams of hardened CoCr, a regression fatigue limit of 10.8–11.8 MPa, where the stress refers to the arithmetic average shear stress computed along the region dominated by shear loading, is determined.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Materials Science and Environmental Engineering, Orton Orthopaedic Hospital, Surface and Corrosion Science
Contributors: Kanerva, M., Besharat, Z., Pärnänen, T., Jokinen, J., Honkanen, M., Sarlin, E., Göthelid, M., Schlenzka, D.
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Pages: 93-103
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Publication information
Journal: Journal of the Mechanical Behavior of Biomedical Materials
Volume: 99
ISSN (Print): 1751-6161
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Scopus rating (2019): CiteScore 6.6 SJR 0.944 SNIP 1.491
Original language: English
ASJC Scopus subject areas: Biomaterials, Biomedical Engineering, Mechanics of Materials
Keywords: CoCr, Crack growth, Fatigue, Implant, Laser weld
Electronic versions:

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http://urn.fi/URN:NBN:fi:tty-201909052065

Bibliographical note
EXT="Pärnänen, T."
Source: Scopus
Source ID: 85069732362
Research output: Contribution to journal › Article › Scientific › peer-review

Surface science analysis and surface modification methods for biomaterials research

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Research group: Surface Science, Department of Physics, Department of Biomedical Engineering, University of Tampere Institute of Medical Technology, Department of Biomedical Engineering
Contributors: Kanninen, L., Jokinen, N., Lahtonen, K., Jussila, P., Ali-Löytty, H., Hirsimäki, M., Leppiniemi, J., Hytönen, V., Kulomaa, M., Ahola, N., Paakinaho, K., Kellomäki, M., Valden, M.
Number of pages: 1
Pages: 133
Publication date: 1 Jan 2010
Peer-reviewed: Yes

Publication information
Journal: European Cells and Materials
Volume: 20
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ISSN (Print): 1473-2262
Ratings:
Scopus rating (2010): SJR 0.192 SNIP 0.193
Original language: English
ASJC Scopus subject areas: Bioengineering, Biochemistry, Biomaterials, Biomedical Engineering, Cell Biology
URLs:
http://www.scopus.com/inward/record.url?scp=84860892200&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84860892200
Research output: Contribution to journal › Article › Scientific › peer-review

Effect of sol-gel derived in situ silica on the morphology and mechanical behavior of natural rubber and acrylonitrile butadiene rubber blends
Silica particles were generated and grown in situ by sol-gel method into rubber blends comprised of natural rubber (NR) and acrylonitrile butadiene rubber (NBR) at various blend ratios. Silica formed into rubber matrix was amorphous in nature. Amount of in situ silica increased with increase in natural rubber proportion in the blends during the sol-gel process. Morphology studies showed that the generated in situ silica were nanoparticles of different shapes and sizes mostly grown into the NR phase of the blends. In situ silica filled NR/NBR blend composites showed improvement in the mechanical and dynamic mechanical behaviors in comparison to those of the unfilled and externally filled NR/ NBR blend composites. For the NR/NBR blend at 40/60 composition, in particular, the improvement was appreciable where size and dispersion of the silica particles into the rubber matrix were found to be more uniform. Dynamic mechanical analysis revealed a strong rubber-in situ silica interaction as indicated by a positive shift of the glass transition temperature of both the rubber phases in the blends.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Engineering materials science and solutions (EMASS), Visvesvaraya National Institute of Technology, Leibniz-Institut für Polymerforschung Dresden E.V.
Contributors: Kapgate, B. P., Das, C., Das, A., Basu, D., Reuter, U., Heinrich, G.
Number of pages: 9
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Peer-reviewed: Yes

Publication information
Journal: JOURNAL OF SOL-GEL SCIENCE AND TECHNOLOGY
Volume: 63
Issue number: 3
ISSN (Print): 0928-0707
Ratings:

Scopus rating (2012): CiteScore 2.8 SJR 0.732 SNIP 1.133
Original language: English
ASJC Scopus subject areas: Chemistry(all), Condensed Matter Physics, Biomaterials, Ceramics and Composites, Electronic, Optical and Magnetic Materials, Materials Chemistry
Keywords: In situ silica, Reinforcement, Rubber blend, Rubber-filler interaction, Sol-gel
DOIs:

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URLs:

http://www.scopus.com/inward/record.url?scp=84875426374&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84875426374
Research output: Contribution to journal › Article › Scientific › peer-review

Picosecond laser-induced polymerization of highly porous microscaffolds

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Integrated Technologies for Tissue Engineering Research (ITTE), Department of Biomedical Engineering
Contributors: Käpylä, E., Aydogan, D. B., Turunen, S., Hyttinen, J., Kellomäki, M.
Publication date: 2011

Host publication information
Title of host publication: 24th European Conference on Biomaterials - Annual Conference of the European Society for Biomaterials, ESB 2011
ASJC Scopus subject areas: Biomaterials
URLs:

http://www.scopus.com/inward/record.url?scp=84887010933&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84887010933
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

The production of injectable hydrazone crosslinked gellan gum-hyaluronan-hydrogels with tunable mechanical and physical properties
Gellan gum (GG) has been proposed for use in tissue engineering (TE) due to its structural and functional similarities with alginate. The most traditional crosslinking methods of GG, ionical and photocrosslinking, have downsides such as loss of stability or phototoxicity, which can limit their use in certain applications. In this study, an alternative hydrazone crosslinking method is introduced. Hydrazone crosslinking is a simple method that produces no toxic reagents or side-products. The method enables the fabrication of injectable hydrogels. GG was combined with hyaluronan (HA) to improve some properties such as cell attachment. The mechanical and physical properties of GG-HA hydrogels were controlled by changing the molecular weight, the degree of modification, and the ratio of polymer components. GG-HA hydrogels showed ionic nature of deswelling in the presence of cations enabling the control of physical properties in different solution environments. Due to the non-linear elastic behavior of hydrogels and tissues, the stiffness as a function of strain was represented instead of solely giving the second-order elastic constants. The stiffness of GG-HA hydrogels was similar to that of soft tissues at small strains.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Faculty of Biomedical Sciences and Engineering, Materials Science, Research group: Biomaterials and Tissue Engineering Group, BioMediTech
Contributors: Karvinen, J., Koivisto, J. T., Jönkkäri, I., Kellomäki, M.
Number of pages: 9
Pages: 383-391
Publication date: 1 Jul 2017
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Volume: 71
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Ratings:

Scopus rating (2017): CiteScore 5.5 SJR 0.958 SNIP 1.447
Original language: English
ASJC Scopus subject areas: Biomaterials, Biomedical Engineering, Mechanics of Materials
Keywords: Gellan gum, Hyaluronan, Hydrazone, Hydrogel, Stiffness
DOIs:

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Source: Scopus
Source ID: 85017457699
Research output: Contribution to journal › Article › Scientific › peer-review

Bioamine-crosslinked gellan gum hydrogel for neural tissue engineering

Neural tissue engineering and three-dimensional in vitro tissue modeling require the development of biomaterials that take into account the specified requirements of human neural cells and tissue. In this study, an alternative method of producing biomimetic hydrogels based on gellan gum (GG) was developed by replacing traditional crosslinking methods with the bioamines spermidine and spermine. These bioamines were proven to function as crosslinkers for GG hydrogel at +37 °C, allowing for the encapsulation of human neurons. We studied the mechanical and rheological properties of the formed hydrogels, which showed biomimicking properties comparable to naïve rabbit brain tissue under physiologically relevant stress and strain. Human pluripotent stem cell-derived neuronal cells demonstrated good cytocompatibility in the GG-based hydrogels. Moreover, functionalization of GG hydrogels with laminin resulted in cell type-specific behavior: neuronal cell maturation and neurite migration.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: BioMediTech, Faculty of Biomedical Sciences and Engineering, Research group: Biomaterials and Tissue Engineering Group, Materials Science, Research group: Plastics and Elastomer Technology, BioMediTech Institute and Faculty of Medicine and Life Sciences
Contributors: Koivisto, J. T., Joki, T., Parraga, J. E., Paakkönen, R., Yla-Outinen, L., Salonen, L., Jönkkäri, I., Peltola, M., Ihalainen, T. O., Narkilahti, S., Kellomäki, M.
Publication date: 24 Mar 2017
Peer-reviewed: Yes

Publication information

Journal: Biomedical Materials
Volume: 12
Issue number: 2
Article number: 025014
ISSN (Print): 1748-6041
Ratings:

Scopus rating (2017): CiteScore 4.5 SJR 0.768 SNIP 0.8
Original language: English
ASJC Scopus subject areas: Bioengineering, Biomaterials, Biomedical Engineering
Keywords: 3D cell culture, gellan gum, human pluripotent stem cells, hydrogel, laminin, neuronal cells
DOIs:

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Bibliographical note

EXT="Ihalainen, Teemu O."
Source: Scopus
Source ID: 85018274634
Research output: Contribution to journal › Article › Scientific › peer-review

A COMPARATIVE IN VITRO STUDY OF CELL GROWTH ON TEXTILE SCAFFOLDS FOR TISSUE ENGINEERING APPLICATIONS

General information

Publication status: Published
MoE publication type: Not Eligible
Organisations: Faculty of Biomedical Sciences and Engineering, Research group: Biomaterials and Tissue Engineering Group, Tampere University of Technology, BioMediTech, University of Tampere, BioMediTech, Adult Stem Cell Research Group

Contributors: Kroon, M., Talvitie, E., Miettinen, S., Kellomäki, M.
Publication date: 12 Sep 2018
Peer-reviewed: Unknown
Event: Paper presented at ESB2018 - 29th Annual Meeting of European Society for Biomaterials, Maastricht, Netherlands.
ASJC Scopus subject areas: Biomaterials, Biomedical Engineering
Research output: Other conference contribution › Paper, poster or abstract › Scientific

Cell response to round and star-shaped polylactide fibers

The surface topography of tissue engineering biomaterials is known to affect cell behavior. Polymer fibers can be processed into a variety of diameters and shapes, which both affect the orientation and organization of cells. The fibers can be used to manufacture tissue engineering scaffolds. The aim of this work was to study cell response to microfibers with round and star-shaped cross-sections. In addition, the retention of fiber properties during hydrolytic degradation was evaluated.

Melt spinning method was used to process poly-L/D-lactide 96/4 (PLDLA 96/4) fibers. Knitted scaffolds were manufactured from the fibers for the cell culture experiment. A hydrolytic degradation experiment was conducted for the fibers to evaluate retention of mechanical properties and changes in crystallinity and thermal properties. Human urothelial cells (hUCs) and human foreskin fibroblasts (hFFs) were used in the cell culture experiment. Cell response was assessed using live/dead analysis and crystal violet staining.

Both fibers had suitable mechanical properties to be processed into knitted scaffolds. The hydrolytic degradation experiment demonstrated good retention of properties for the fibers. The number of cells attached to the fibers increased throughout the experiment. The hFFs oriented to the fiber direction on both fibers. The cell culture experiment demonstrated good biocompatibility and no observable difference in cell response was seen between the fiber types.

General information

Publication status: Published
Organisations: Faculty of Biomedical Sciences and Engineering, Research group: Biomaterials and Tissue Engineering Group, University of Tampere, Faculty of Medicine and Life Sciences, Lääkärinkatu 1, 33520 Tampere, Finland, Adult Stem Cell Research Group
Contributors: Kroon, M., Talvitie, E., Miettinen, S., Kellomäki, M.
Publication date: 23 Nov 2018
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Event: Paper presented at BioMediTech Research Day 2018, Tampere, Finland.
ASJC Scopus subject areas: Biomaterials
Keywords: Polylactide, Tissue Engineering, Cell Culture, Scaffolds, Biotextiles
Research output: Other conference contribution › Paper, poster or abstract › Scientific

Fluid flow simulations meet high-speed video: Computer vision comparison of droplet dynamics

Hypothesis: While multiphase flows, particularly droplet dynamics, are ordinary in nature as well as in industrial processes, their mathematical and computational modelling continue to pose challenging research tasks - patent approaches for tackling them are yet to be found. The lack of analytical flow field solutions for non-trivial droplet dynamics hinders validation of computer simulations and, hence, their application in research problems. High-speed videos and computer vision algorithms can provide a viable approach to validate simulations directly against experiments. Experiments: Droplets of water (or glycerol-water mixtures) impacting on both hydrophobic and superhydrophobic surfaces were imaged with a high-speed camera. The corresponding configurations were simulated using a lattice-Boltzmann multiphase scheme. Video frames from experiments and simulations were compared, by means of computer vision, over entire droplet impact events. Findings: The proposed experimental validation procedure provides a detailed, dynamic one-on-one comparison of a droplet impact. The procedure relies on high-speed video recording of the experiments, computer vision, and on a software package for the analyzation routines. The procedure is able to quantitatively validate computer simulations against experiments and it is widely applicable to multiphase flow systems in general.

General information

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Organisations: Physics, Natural Resources Institute Finland (Luke), BioFluidix GmbH, Faculty of Information Technology, Jyväskylän yliopisto
Contributors: Kulju, S., Riegger, L., Koltay, P., Mattila, K., Hyväluoma, J.
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Publication date: 15 Jul 2018
Peer-reviewed: Yes

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ISSN (Print): 0021-9797
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Original language: English
ASJC Scopus subject areas: Electronic, Optical and Magnetic Materials, Biomaterials, Surfaces, Coatings and Films, Colloid and Surface Chemistry
Keywords: Computer vision, Droplet, Experimental, High-speed video, Hydrophobic, Lattice Boltzmann, Simulation
DOIs:

10.1016/j.jcis.2018.03.053

Bibliographical note
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Source: Scopus
Source ID: 85044153494
Research output: Contribution to journal › Article › Scientific › peer-review

Osteointegration of PLGA implants with nanostructured or microsized β-TCP particles in a minipig model
Bioresorbable suture anchors and interference screws have certain benefits over equivalent titanium-alloy implants. However, there is a need for compositional improvement of currently used bioresorbable implants. We hypothesized that implants made of poly(. l-lactide-co-glycolide) (PLGA) compounded with nanostructured particles of beta-tricalcium phosphate (β-TCP) would induce stronger osteointegration than implants made of PLGA compounded with microsized β-TCP particles. The experimental nanostructured self-reinforced PLGA (85L:15G)/β-TCP composite was made by high-energy ball-milling. Self-reinforced microsized PLGA (95L:5G)/β-TCP composite was prepared by melt-compounding. The composites were characterized by gas chromatography, Ubbelohde viscometry, scanning electron microscopy, laser diffractometry, and standard mechanical tests. Four groups of implants were prepared for the controlled laboratory study employing a minipig animal model. Implants in the first two groups were prepared from nanostructured and microsized PLGA/β-TCP composites respectively. Microroughened titanium-alloy (Ti6Al4V) implants served as positive intra-animal control, and pure PLGA implants as negative control. Cone-shaped implants were inserted in a random order unilaterally in the anterior cortex of the femoral shaft. Eight weeks after surgery, the mechanical strength of osteointegration of the implants was measured by a push-out test. The quality of new bone surrounding the implant was assessed by microcomputed tomography and histology. Implants made of nanostructured PLGA/β-TCP composite did not show improved mechanical osteointegration compared with the implants made of microsized PLGA/β-TCP composite. In the intra-animal comparison, the push-out force of two PLGA/β-TCP composites was 35-60% of that obtained with Ti6Al4V implants. The implant materials did not result in distinct differences in quality of new bone surrounding the implant.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Engineering materials science and solutions (EMASS), Turun Yliopisto/Turun Biomateriaalikeskus, University of Turku, Conmed Linvatec Biomaterials Ltd., Turku University Hospital
Contributors: Kulkova, J., Moritz, N., Suokas, E. O., Strandberg, N., Leino, K. A., Laitio, T. T., Aro, H. T.
Number of pages: 11
Pages: 190-200
Publication date: 1 Dec 2014
Peer-reviewed: Yes

Publication information
Journal: Journal of the Mechanical Behavior of Biomedical Materials
Volume: 40
ISSN (Print): 1751-6161
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Scopus rating (2014): CiteScore 5.1 SJR 1.103 SNIP 1.813
Original language: English
ASJC Scopus subject areas: Biomaterials, Biomedical Engineering, Mechanics of Materials, Medicine(all)
Keywords: Beta-tricalcium phosphate, Bioresorbable bone implants, Composite, Minipig, Nanostructure, Poly(l-lactide-co-glycolide)
DOIs:

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URLs:

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Source: Scopus
Source ID: 84907564531
Research output: Contribution to journal › Article › Scientific › peer-review

Preparation and antimicrobial characterization of silver-containing packaging materials for meat

In food technology, antimicrobial packaging materials could inhibit or limit the growth of spoilage bacteria and thus improve the shelf life of packaged products. The present study provides new insights into the preparation and antimicrobial characterization of silver-containing packaging materials and their efficacy against typical meat spoilage bacteria. Antimicrobial efficacy of packaging films produced by coextrusion or liquid flame spray process was determined by bioluminescence imaging and conventional antimicrobial assay. Fresh pork sirloin was packaged in selected films and composition of meat microbiota was analyzed by 16S rRNA amplicon sequencing. Shelf life of meat was not affected by any of the silver-containing packaging films, even though meat microbiota mostly consisted of bacteria that were inhibited or retarded in vitro by nanoscale silver coating. This may be due to different release dynamics of silver ions on meat surfaces compared to the circumstances in the antimicrobial assay or interactions between silver and amino acids.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Materials Science, Research group: Paper Converting and Packaging, Department of Chemistry and Bioengineering, Engineering materials science and solutions (EMASS), Urban circular bioeconomy (UrCirBio), University of Helsinki, Department of Food Hygiene and Environmental Health
Contributors: Kuuliala, L., Pippuri, T., Hultman, J., Auvinen, S., Kolppo, K., Nieminen, T., Karp, M., Björkroth, J., Kuusipalo, J., Jääskeläinen, E.
Number of pages: 8
Pages: 53-60
Publication date: 1 Dec 2015
Peer-reviewed: Yes

Publication information

Journal: Food Packaging and Shelf Life
Volume: 6
Article number: 67
ISSN (Print): 2214-2894
Ratings:

Scopus rating (2015): CiteScore 1.6 SJR 0.695 SNIP 0.985
Original language: English
ASJC Scopus subject areas: Food Science, Safety, Risk, Reliability and Quality, Biomaterials, Polymers and Plastics, Microbiology (medical)
Keywords: Active packaging, Antimicrobial film, Bioluminescence, Lactic acid bacteria, Liquid flame spray, Silver nanoparticle
DOIs:

10.1016/j.fpsl.2015.09.004
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http://www.scopus.com/inward/record.url?scp=84945244937&partnerID=8YFLogxK (Link to publication in Scopus)

Bibliographical note

ORG=mol,0.5
ORG=keb,0.5
Source: Scopus
Source ID: 84945244937
Research output: Contribution to journal › Article › Scientific › peer-review

Improved properties for packaging materials by nanoscale surface modification and ALD barrier coating

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Department of Materials Science, Research group: Paper Converting and Packaging, Metsä Board, Bemis , LUT Energy, Masaryk University
Contributors: Lahti, J., Lavonen, J., Lahtinen, K., Johansson, P., Seppänen, T., Cameron, D. C.
Number of pages: 23
Pages: 684-706
Publication date: 2016

Host publication information

Title of host publication: TAPPI International Conference on Nanotechnology for Renewable Materials 2016
Volume: 2

Publisher: TAPPI Press
ISBN (Electronic): 9781510828001
ASJC Scopus subject areas: Biotechnology, Biomaterials, Materials Chemistry, Surfaces, Coatings and Films
URLs:

http://www.scopus.com/inward/record.url?scp=84992694476&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84992694476
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Roll-to-roll atomic layer deposition for flexible substrates

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Department of Materials Science, Engineering materials science and solutions (EMASS), Lappeenranta University of Technology
Contributors: Lahtinen, K., Maydannik, P., Kääriäinen, T., Seppänen, T., Cameron, D. C., Johansson, P., Kraft, M., Kuusipalo, J.
Number of pages: 14
Pages: 726-739
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Title of host publication: TAPPI International Conference on Nanotechnology 2013
Publisher: TAPPI Press
ISBN (Electronic): 9781510815681
ASJC Scopus subject areas: Biomaterials, Biotechnology, Renewable Energy, Sustainability and the Environment
URLs:

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Source: Scopus
Source ID: 84966539214
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Simulation of developing human neuronal cell networks
Background: Microelectrode array (MEA) is a widely used technique to study for example the functional properties of neuronal networks derived from human embryonic stem cells (hESC-NN). With hESC-NN, we can investigate the earliest developmental stages of neuronal network formation in the human brain. Methods: In this paper, we propose an in silico model of maturating hESC-NNs based on a phenomenological model called INEX. We focus on simulations of the development of bursts in hESC-NNs, which are the main feature of neuronal activation patterns. The model was developed with data from developing hESC-NN recordings on MEAs which showed increase in the neuronal activity during the investigated six measurement time points in the experimental and simulated data. Results: Our simulations suggest that the maturation process of hESC-NN, resulting in the formation of bursts, can be explained by the development of synapses. Moreover, spike and burst rate both decreased at the last measurement time point suggesting a pruning of synapses as the weak ones are removed. Conclusions: To conclude, our model reflects the assumption that the interaction between excitatory and inhibitory neurons during the maturation of a neuronal network and the spontaneous emergence of bursts are due to increased connectivity caused by the forming of new synapses.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, BioMediTech, Faculty of Engineering and Computer Science, School of Management (JKK)
Contributors: Lenk, K., Priwitzer, B., Ylä-Outinen, L., Tietz, L. H. B., Narkilahti, S., Hyttinen, J. A.
Publication date: 30 Aug 2016
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Publication information
Journal: BioMedical Engineering Online
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Article number: 105
ISSN (Print): 1475-925X
Ratings:

Scopus rating (2016): CiteScore 3.4 SJR 0.572 SNIP 1.165

Original language: English
ASJC Scopus subject areas: Radiological and Ultrasound Technology, Biomaterials, Biomedical Engineering, Radiology Nuclear Medicine and imaging
Keywords: Development, Human embryonic stem cells, Microelectrode array, Neuronal networks, Simulation
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Simulation of developing human neuronal cell networks
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http://urn.fi/URN:NBN:fi:tty-201609294563

Bibliographical note
EXT="Ylä-Outinen, Laura"
Source: Scopus
Source ID: 84984652694
Research output: Contribution to journal › Article › Scientific › peer-review

Interstitial photodynamic therapy and glioblastoma: Light fractionation study on a preclinical model: Preliminary results
Background: Glioblastoma is a high-grade cerebral tumor with local recurrence and poor outcome. Photodynamic therapy (PDT) is a local treatment based on the light activation of a photosensitizer (PS) in the presence of oxygen to form cytotoxic species. Fractionation of light delivery may enhance treatment efficiency by restoring tissue oxygenation. Objectives: To evaluate the efficiency of light fractionation using MRI imaging, including diffusion and perfusion, compared to histological data. Materials and Methods: Thirty-nine "Nude" rats were grafted with human U87 cells into the right putamen. After PS precursor intake (5-ALA), an optic fiber was introduced into the tumor. The rats were randomized in three groups: without illumination, with monofractionated illumination and the third one with multifractionated light. Treatment effects were assessed with early MRI including diffusion and perfusion sequences. The animals were eventually sacrificed to perform brain histology. Results: On MRI, we observed elevated diffusion values in the center of the tumor among treated animals, especially in multifractionated group. Perfusion decreased around the treatment site, all the more in the multifractionated group. Histology confirmed our MRI findings, with a more extensive necrosis and associated with a rarified angiogenic network in the treatment area, after multifractionated PDT. However, we observed more surrounding edema and neovascularization in the peripheral ring after multifractionated PDT. Conclusion: Fractionated interstitial PDT induced specific tumoral lesions. The multifractionated scheme was more efficient, inducing increased tumoral necrosis, but it also caused significant peripheral edema and neovascularization. Diffusion and perfusion MRI imaging were able to predict the histological lesions.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Frontier Photonics, Lille University Hospital, Univ Paris 06, Centre National de la Recherche Scientifique (CNRS), Pierre & Marie Curie University - Paris 6, Institut de Recherche pour le Developpement (IRD), Inria, Institut National de la Sante et de la Recherche Medicale (Inserm), Univ Sorbonne, CNRS,ICM,UMR S 1127,UMR 7225,U1127, INSERM,Inria Paris Rocquencourt,Inst Cerveau & Mo
Contributors: Leroy, H. A., Vermandel, M., Tétard, M. C., Lejeune, J. P., Mordon, S., Reyns, N.
Publication date: 2015

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Title of host publication: Optical Techniques in Neurosurgery, Neurophotonics, and Optogenetics II
Volume: 9305
Publisher: SPIE
Article number: 93050D
ISBN (Electronic): 9781628413953
ASJC Scopus subject areas: Atomic and Molecular Physics, and Optics, Electronic, Optical and Magnetic Materials, Biomaterials, Radiology Nuclear Medicine and imaging
DOIs:

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URLs:

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Source: Scopus
Source ID: 84928128691
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Photostable second-harmonic generation from a single KTiOPO4 nanocrystal for nonlinear microscopy
A study was conducted to report the observation and the characterization of nanometric-sized crystals extracted by centrifugation from KTP (potassium titanyl phosphate) powder. In situ atomic force microscopy (AFM) analysis of its size and analysis of its second-harmonic emission properties were performed for a well-isolated single nanocrystal. The highly

efficient nonlinear response leads to the emission of several SHG photons and in a photostable and blinking-free manner due to non-resonant coherent interaction. The study retrieved the in situ three-dimensional crystal orientation by recovering the radiation pattern from the recorded defocused images. Solution-based chemical synthesis of KTP nanocrystals with a monodisperse size controlled by capping agents should lead to optimized KTP nanocrystallites and to a more accurate estimate of the size-detection threshold. Fully characterized nano-KTPs are also attractive for the development of novel schemes of nonlinear microscopy.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Laboratoire de Photonique Quantique et Moléculaire-ENS Cachan, UMR CNRS 8537, Laboratoire de Physique de la Matière Condensée-Ecole Polytechnique-CNRS, Ecole Polytechnique, Cristal Laser S.A.
Contributors: Le Xuan, L., Zhou, C., Slablab, A., Chauvat, D., Tard, C., Perruchas, S., Gacoin, T., Villeval, P., Roch, J.
Number of pages: 5
Pages: 1332-1336
Publication date: Sep 2008
Peer-reviewed: Yes

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Volume: 4
Issue number: 9
ISSN (Print): 1613-6810
Ratings:

Scopus rating (2008): SJR 3.884 SNIP 1.517
Original language: English
ASJC Scopus subject areas: Biomaterials, Engineering (miscellaneous), Biotechnology, Medicine(all)
Keywords: Nanocrystals, Nanoparticles, Nonlinear microscopy, Second-harmonic generation
DOIs:

10.1002/smll.200701093
URLs:

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Source: Scopus
Source ID: 52649175511
Research output: Contribution to journal › Article › Scientific › peer-review

Rational design of a printable, highly conductive silicone-based electrically conductive adhesive for stretchable radio-frequency antennas

Stretchable radio-frequency electronics are gaining popularity as a result of the increased functionality they gain through their flexible nature, impossible within the confines of rigid and planar substrates. One approach to fabricating stretchable antennas is to embed stretchable or flowable conductive materials, such as conductive polymers, conductive polymer composites, and liquid metal alloys as stretchable conduction lines. However, these conductive materials face many challenges, such as low electrical conductivity under mechanical deformation and delamination from substrates. In the present study, a silicone-based electrically conductive adhesive (silo-ECA) is developed that have a conductivity of 1.51×10^{4} S cm $^{-1}$ and can maintain conductivity above 1.11×10^{3} S cm^{-1} , even at a large stain of 240%. By using the stretchable silo- ECAs as a conductor pattern and pure silicone elastomers as a base substrate, stretchable antennas can be fabricated by stencil printing or soft-lithography. The resulting antenna's resonant frequency is tunable over a wide range by mechanical modulation. This fabrication method is low-cost, can support large-scale production, has high reliability over a wide temperature range, and eliminates the concerns of leaking or delamination between conductor and substrate experienced in previously reported micro-fluidic antennas.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Sensing Systems for Wireless Medicine (MediSense), Georgia Institute of Technology, Chinese University of Hong Kong
Contributors: Li, Z., Le, T., Wu, Z., Yao, Y., Li, L., Tentzeris, M., Moon, K. S., Wong, C. P.
Number of pages: 7
Pages: 464-470
Publication date: 21 Jan 2015
Peer-reviewed: Yes

Publication information

Journal: Advanced Functional Materials
Volume: 25

Issue number: 3
ISSN (Print): 1616-301X
Ratings:

Scopus rating (2015): CiteScore 20.4 SJR 4.859 SNIP 2.439
Original language: English
ASJC Scopus subject areas: Electronic, Optical and Magnetic Materials, Biomaterials, Condensed Matter Physics, Electrochemistry
DOIs:

10.1002/adfm.201403275
URLs:

http://www.scopus.com/inward/record.url?scp=84920994935&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84920994935
Research output: Contribution to journal › Article › Scientific › peer-review

The influence of high-temperature sulfuric acid solution ageing on the properties of laminated vinyl-ester joints

A carbon fiber powder doped corrosion layer is used as an inner layer in large composite tanks to improve their chemical and wear resistance. In joints fabricated on site, this layer is embedded into the structure. This study evaluates the lap shear strength of specimens, simulating a laminated joint in between the corrosion layer and the inner joint laminate. Lap-shear tests were carried out for as-fabricated and aged laminates at room temperature and at elevated temperature. Ageing was carried out for half a year in a 95 °C pressurized sulfuric acid solution. The tests showed that, after ageing, the room temperature shear strength remained unaltered but high-temperature shear strength was lowered. When the temperature increased, the failure location shifted from the interface between the doped layer and the joint laminate to the doped layer. Thermal analysis and microscopy were employed to clarify the reasons for the observed behavior.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Materials Science, Research group: Plastics and Elastomer Technology, Outotec Research Center, Aalto University
Contributors: Lindgren, M., Wallin, M., Kakkonen, M., Saarela, O., Vuorinen, J.
Number of pages: 7
Pages: 298-304
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Publication information

Journal: International Journal of Adhesion and Adhesives
Volume: 68
ISSN (Print): 0143-7496
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Scopus rating (2016): CiteScore 4 SJR 0.919 SNIP 1.516
Original language: English
ASJC Scopus subject areas: Chemical Engineering(all), Biomaterials, Polymers and Plastics
Keywords: Aging, Lap-shear, Sulfuric acid, Vinyl ester
DOIs:

10.1016/j.ijadhadh.2016.04.011

Bibliographical note

EXT="Lindgren, M."
Source: Scopus
Source ID: 84973340146
Research output: Contribution to journal › Article › Scientific › peer-review

The Role of Temperature and Lipid Charge on Intake/Uptake of Cationic Gold Nanoparticles into Lipid Bilayers

Understanding the molecular mechanisms governing nanoparticle–membrane interactions is of prime importance for drug delivery and biomedical applications. Neutron reflectometry (NR) experiments are combined with atomistic and coarse-grained molecular dynamics (MD) simulations to study the interaction between cationic gold nanoparticles (AuNPs) and model lipid membranes composed of a mixture of zwitterionic di-stearoyl-phosphatidylcholine (DSPC) and anionic di-stearoyl-phosphatidylglycerol (DSPG). MD simulations show that the interaction between AuNPs and a pure DSPC lipid bilayer is modulated by a free energy barrier. This can be overcome by increasing temperature, which promotes an irreversible AuNP incorporation into the lipid bilayer. NR experiments confirm the encapsulation of the AuNPs within the lipid bilayer at temperatures around 55 °C. In contrast, the AuNP adsorption is weak and impaired by heating for a DSPC–DSPG (3:1) lipid bilayer. These results demonstrate that both the lipid charge and the temperature play pivotal roles in AuNP–membrane interactions. Furthermore, NR experiments indicate that the (negative) DSPG lipids are

associated with lipid extraction upon AuNP adsorption, which is confirmed by coarse-grained MD simulations as a lipid-crawling effect driving further AuNP aggregation. Overall, the obtained detailed molecular view of the interaction mechanisms sheds light on AuNP incorporation and membrane destabilization.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Research group: Biological Physics and Soft Matter, Research area: Computational Physics, Physics, Computational Physics Laboratory, University of Helsinki, Politecnico di Milano, Institut Laue-Langevin, Max Planck Institute of Colloids and Interfaces, MEMPHYS−Center for Biomembrane Physics, Norwegian Univ. of Sci. and Technol., G2Elab/Institut Néel
Contributors: Lolicato, F., Joly, L., Martinez-Seara, H., Fragneto, G., Scoppola, E., Baldelli Bombelli, F., Vattulainen, I., Akola, J., Maccarini, M.
Publication date: 7 Jun 2019
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Publication information

Journal: Small
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Issue number: 23
Article number: 1805046
ISSN (Print): 1613-6810
Ratings:

Scopus rating (2019): CiteScore 15.7 SJR 3.717 SNIP 1.695
Original language: English
ASJC Scopus subject areas: Biotechnology, Biomaterials, Chemistry(all), Materials Science(all)
Keywords: gold nanoparticles, lipid membranes, molecular dynamics simulations, nanotoxicity, neutron reflectometry
Electronic versions:

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DOIs:

10.1002/smll.201805046
URLs:

http://urn.fi/URN:NBN:fi:tty-201906141891

Bibliographical note

EXT="Martinez-Seara, Hector"
Source: Scopus
Source ID: 85064688737
Research output: Contribution to journal › Article › Scientific › peer-review

Focal Laser Ablation of Prostate Cancer: Numerical Simulation of Temperature and Damage Distribution

Background: The use of minimally invasive ablative techniques in the management of patients with low grade and localized prostate tumours could represent a treatment option between active surveillance and radical therapy. Focal laser ablation (FLA) could be one of these treatment modalities. Dosimetry planning and conformation of the treated area to the tumor remain major issues, especially when, several fibers are required. An effective method to perform pre-treatment planning of this therapy is computer simulation. In this study we present an in vivo validation of a mathematical model.Methods: The simulation model is based on finite elements method (FEM) to solve the bio-heat and the thermal damage equations. Laser irradiation was performed with a 980 nm laser diode system (5 W, 75 s). Light was transmitted using a cylindrical diffusing fiber inserted inside a preclinical animal prostate cancer model induced in Copenhagen rats. Non-enhanced T2-weighted and dynamic gadolinium-enhanced T1-weighted MR imaging examinations were performed at baseline and 48 hours after the procedure. The model was validated by comparing the simulated necrosis volume to the results obtained in vivo on (MRI) and by histological analysis. 3 iso-damage temperatures were considered 43° C, 45° C and 50° C.Results: The mean volume of the tissue necrosis, estimated from the histological analyses was 0.974 ± 0.059 cc and 0.98 ± 0.052 cc on the 48 h MR images. For the simulation model, volumes were: 1.38 cc when T = 43° C, 1.1 cc for T = 45°C and 0.99 cc when T = 50 C°.Conclusions: In this study, a clear correlation was established between simulation and in vivo experiments of FLA for prostate cancer.Simulation is a promising planning technique for this therapy. It needs further more evaluation to allow to FLA to become a widely applied surgical method.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Frontier Photonics, Univ Lille Nord de France, Lille University Hospital - CHRU, Inserm (French National Institute of Health and Medical Research), National Institutes of Health, Bethesda
Contributors: Marqa, M. F., Colin, P., Nevoux, P., Mordon, S. R., Betrouni, N.
Publication date: 2 Jun 2011

Peer-reviewed: Yes

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Journal: BioMedical Engineering Online
Volume: 10
Article number: 45
ISSN (Print): 1475-925X
Ratings:

Scopus rating (2011): CiteScore 2.1 SJR 0.517 SNIP 1.201
Original language: English
ASJC Scopus subject areas: Biomedical Engineering, Radiological and Ultrasound Technology, Radiology Nuclear Medicine and imaging, Biomaterials
Keywords: bioheat transfer simulation, Prostate cancerfocal laser ablationthermal damage
DOIs:

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URLs:

http://www.scopus.com/inward/record.url?scp=79957840008&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 79957840008
Research output: Contribution to journal › Article › Scientific › peer-review

The influence of SrO and CaO in silicate and phosphate bioactive glasses on human gingival fibroblasts
In this paper, we investigate the effect of substituting SrO for CaO in silicate and phosphate bioactive glasses on the human gingival fibroblast activity. In both materials the presence of SrO led to the formation of a CaP layer with partial Sr substitution for Ca. The layer at the surface of the silicate glass consisted of HAP whereas at the phosphate glasses it was close to the DCPD composition. In silicate glasses, SrO gave a faster initial dissolution and a thinner reaction layer probably allowing for a continuous ion release into the solution. In phosphate glasses, SrO decreased the dissolution process and gave a more strongly bonded reaction layer. Overall, the SrO-containing silicate glass led to a slight enhancement in the activity of the gingival fibroblasts cells when compared to the SrO-free reference glass, S53P4. The cell activity decreased up to 3 days of culturing for all phosphate glasses containing SrO. Whereas culturing together with the SrO-free phosphate glass led to complete cell death at 7 days. The glasses containing SrO showed rapid cell proliferation and growth between 7 and 14 days, reaching similar activity than glass S53P4. The addition of SrO in both silicate and phosphate glasses was assumed beneficial for proliferation and growth of human gingival fibroblasts due to Sr incorporation in the reaction layer at the glass surface and released in the cell culture medium.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Research group: Biomaterials and Tissue Engineering Group, Integrated Technologies for Tissue Engineering Research (ITTE), Turun Yliopisto/Turun Biomateriaalikeskus, Åbo Akademi University, Process Chemistry Centre, University of Turku, Department of Prosthetic Dentistry, Clinic of Oral Diseases, Turku University Central Hospital
Contributors: Massera, J., Kokkari, A., Närhi, T., Hupa, L.
Publication date: 25 Jun 2015
Peer-reviewed: Yes

Publication information
Journal: Journal of Materials Science: Materials in Medicine
Volume: 26
Issue number: 6
Article number: 196
ISSN (Print): 0957-4530
Ratings:

Scopus rating (2015): CiteScore 4.8 SJR 0.786 SNIP 1.018
Original language: English
ASJC Scopus subject areas: Biophysics, Biomaterials, Bioengineering, Biomedical Engineering
DOIs:

10.1007/s10856-015-5528-x
Source: Scopus
Source ID: 84935013205
Research output: Contribution to journal › Article › Scientific › peer-review

In-vitro dissolution characteristics and human adipose stem cell response to novel borophosphate glasses
The main drawbacks of traditional silicate bioactive glasses are their narrow hot forming domain and noncongruent dissolution. In this article, we report on new borophosphate glasses [$xM_nO_m + (100 - x)(47.5P_2O_5 + 2.5B_2O_3 + 10Na_2$

O + 20CaO + 20SrO)], M_nO_m being CuO, Ag_2O, and CeO_2, having high thermal processability, hence suitable for fiber drawing and sintering into scaffolds. Furthermore, the glasses dissolve congruently in simulated body fluid (SBF) and TRIS buffer solution, eventually leading to the precipitation of a reactive layer. Human adipose stem cells (hASC) were cultured in media enriched with glass extract at different dilutions, to investigate the optimal ion concentration for cell survival. Cells grew in all the extracts, except in the undiluted Cu-doped glass extract. At dilution 1:10, the lactate dehydrogenase (LDH) activity and cell proliferation were comparable to the control, while at 1:100, the cells proliferated faster than the control. Thus, the reference (undoped), Ag and Ce-doped glasses were found to be suitable for cell viability and proliferation. Cytotoxicity assessments using the LDH assay indeed revealed the high cytotoxicity of the Cu extract. This raises questions about the use of Cu in bioactive glasses and its optimal concentration as a dopant.

General information
Publication status: Accepted/In press
MoE publication type: A1 Journal article-refereed
Organisations: BioMediTech, Health Sciences, Adult Stem Cell Group, Tampere University, Tampere University Hospital
Contributors: Mishra, A., Ojansivu, M., Autio, R., Vanhatupa, S., Miettinen, S., Massera, J.
Publication date: 2019
Peer-reviewed: Yes

Publication information
Journal: Journal of Biomedical Materials Research - Part A
ISSN (Print): 1549-3296
Ratings:

Scopus rating (2019): CiteScore 6.6 SJR 0.862 SNIP 0.944
Original language: English
ASJC Scopus subject areas: Ceramics and Composites, Biomaterials, Biomedical Engineering, Metals and Alloys
Keywords: bioactive glass, borophosphate glass, cell proliferation, cytotoxicity, in-vitro dissolution
DOIs:

10.1002/jbm.a.36722
Source: Scopus
Source ID: 85066908676
Research output: Contribution to journal › Article › Scientific › peer-review

Influence of strain rate, temperature and fatigue on the radial compression behaviour of Norway spruce
A dynamic elastoplastic compression model of Norway spruce for virtual computer optimization of mechanical pulping processes was developed. The empirical wood behaviour was fitted to a Voigt-Kelvin material model, which is based on quasi static compression and high strain rate compression tests (QSCT and HSRT, respectively) of wood at room temperature and at high temperature (80-100°C). The effect of wood fatigue was also included in the model. Wood compression stress-strain curves have an initial linear elastic region, a plateau region and a densification region. The latter was not reached in the HSRT. Earlywood (EW) and latewood (LW) contributions were considered separately. In the radial direction, the wood structure is layered and can well be modelled by serially loaded layers. The EW model was a two part linear model and the LW was modelled by a linear model, both with a strain rate dependent term. The model corresponds well to the measured values and this is the first compression model for EW and LW that is based on experiments under conditions close to those used in mechanical pulping.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Mechanical Engineering and Industrial Systems, Automation and Hydraulic Engineering, Research area: Measurement Technology and Process Control, Research area: Design, Development and LCM, Aalto University, Mid Sweden University, Sundsvall, VTT Technical Research Centre of Finland
Contributors: Moilanen, C., Björkqvist, T., Ovaska, M., Koivisto, J., Miksic, A., Engberg, B. A., Salminen, L. I., Saarenrinne, P., Alava, M.
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Scopus rating (2017): CiteScore 3.5 SJR 0.709 SNIP 1.011
Original language: English

ASJC Scopus subject areas: Biomaterials
Keywords: dynamic modelling of defibration, earlywood, high strain rate test, latewood, moist Norway spruce, radial compression behaviour, split-Hopkinson pressure bar, Voigt-Kelvin material model
Electronic versions:

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http://urn.fi/URN:NBN:fi:tty-201907151964
Source: Scopus
Source ID: 85020476071
Research output: Contribution to journal › Article › Scientific › peer-review

Toward Rigorous Materials Production: New Approach Methodologies Have Extensive Potential to Improve Current Safety Assessment Practices

Advanced material development, including at the nanoscale, comprises costly and complex challenges coupled to ensuring human and environmental safety. Governmental agencies regulating safety have announced interest toward acceptance of safety data generated under the collective term New Approach Methodologies (NAMs), as such technologies/approaches offer marked potential to progress the integration of safety testing measures during innovation from idea to product launch of nanomaterials. Divided in overall eight main categories, searchable databases for grouping and read across purposes, exposure assessment and modeling, in silico modeling of physicochemical structure and hazard data, in vitro high-throughput and high-content screening assays, dose-response assessments and modeling, analyses of biological processes and toxicity pathways, kinetics and dose extrapolation, consideration of relevant exposure levels and biomarker endpoints typify such useful NAMs. Their application generally agrees with articulated stakeholder needs for improvement of safety testing procedures. They further fit for inclusion and add value in nanomaterials risk assessment tools. Overall 37 of 50 evaluated NAMs and tiered workflows applying NAMs are recommended for considering safer-by-design innovation, including guidance to the selection of specific NAMs in the eight categories. An innovation funnel enriched with safety methods is ultimately proposed under the central aim of promoting rigorous nanomaterials innovation.

General information
Publication status: Published
MoE publication type: A2 Review article in a scientific journal
Organisations: Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Karolinska Institutet, Misvik Biology, National Institute for Public Health and the Environment, TNO, STL Group, Gaiker, University of Helsinki Institute of Biotechnology, National Institute for Occupational Health, University of Witwatersrand, National Research Center for the Work Environment, Health Canada, Tampere University
Contributors: Nymark, P., Bakker, M., Dekkers, S., Franken, R., Fransman, W., García-Bilbao, A., Greco, D., Gulumian, M. , Hadrup, N., Halappanavar, S., Hongisto, V., Hougaard, K. S., Jensen, K. A., Kohonen, P., Koivisto, A. J., Dal Maso, M., Oosterwijk, T., Poikkimäki, M., Rodriguez-Llopis, I., Stierum, R., Sørli, J. B., Grafström, R.
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Publication information
Journal: Small
Volume: 16
Issue number: 6
Article number: 1904749
ISSN (Print): 1613-6810
Original language: English
ASJC Scopus subject areas: Biotechnology, Biomaterials, Chemistry(all), Materials Science(all)
Keywords: human risk assessment tools, nanomaterials, new approach methodologies, safer by design, Stage-Gate innovation funnel
DOIs:

10.1002/smll.201904749

Bibliographical note
INT=bmte, "Greco, Dario"
dupl=51711359
Source: Scopus
Source ID: 85077876153
Research output: Contribution to journal › Review Article › Scientific › peer-review

Bioactive glass ions as strong enhancers of osteogenic differentiation in human adipose stem cells

Bioactive glasses are known for their ability to induce osteogenic differentiation of stem cells. To elucidate the mechanism of the osteoinductivity in more detail, we studied whether ionic extracts prepared from a commercial glass S53P4 and from three experimental glasses (2-06, 1-06 and 3-06) are alone sufficient to induce osteogenic differentiation of human adipose stem cells. Cells were cultured using basic medium or osteogenic medium as extract basis. Our results indicate that cells stay viable in all the glass extracts for the whole culturing period, 14 days. At 14 days the mineralization in osteogenic medium extracts was excessive compared to the control. Parallel to the increased mineralization we observed a decrease in the cell amount. Raman and Laser Induced Breakdown Spectroscopy analyses confirmed that the mineral consisted of calcium phosphates. Consistently, the osteogenic medium extracts also increased osteocalcin production and collagen Type-I accumulation in the extracellular matrix at 13 days. Of the four osteogenic medium extracts, 2-06 and 3-06 induced the best responses of osteogenesis. However, regardless of the enhanced mineral formation, alkaline phosphatase activity was not promoted by the extracts. The osteogenic medium extracts could potentially provide a fast and effective way to differentiate human adipose stem cells in vitro.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Research group: Biomaterials and Tissue Engineering Group, BioMediTech, Integrated Technologies for Tissue Engineering Research (ITTE), Tampere University Hospital, BioMediTech, University of Jyväskylä, Pirkanmaa Hospital District and School of Health Sciences, Adult Stem Cell Research Group, Regenerative Medicine, Adult Stem Cell Group, Johan Gadolin Process Chemistry Centre, Åbo Akademi University, National Center for Nanoscience and Technology (NCNST), Peking, China
Contributors: Ojansivu, M., Vanhatupa, S., Björkvik, L., Häkkänen, H., Kellomäki, M., Autio, R., Ihalainen, J. A., Hupa, L., Miettinen, S.
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Publication information

Journal: Acta Biomaterialia
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Scopus rating (2015): CiteScore 10.9 SJR 2.02 SNIP 1.955
Original language: English
ASJC Scopus subject areas: Biomaterials, Biomedical Engineering, Biotechnology, Biochemistry, Molecular Biology
Keywords: Bioactive glass, Bone tissue engineering, Mesenchymal stem cell, Mineralization, Osteogenic differentiation
DOIs:

10.1016/j.actbio.2015.04.017

Bibliographical note

EXT="Autio, Reija"
Source: Scopus
Source ID: 84929951673
Research output: Contribution to journal › Article › Scientific › peer-review

Bioactive glass induced osteogenic differentiation of human adipose stem cells is dependent on cell attachment mechanism and mitogen-activated protein kinases

Bioactive glasses (BaGs) are widely utilised in bone tissue engineering (TE) but the molecular response of cells to BaGs is poorly understood. To elucidate the mechanisms of cell attachment to BaGs and BaG-induced early osteogenic differentiation, we cultured human adipose stem cells (hASCs) on discs of two silica-based BaGs S53P4 (23.0 Na_2O-20.0 CaO-4.0 P_2O_5-53.0 SiO_2 (wt-%)) and 1-06 (5.9 Na_2O-12.0 K_2O-5.3 MgO-22.6 CaO-4.0 P_2O_5-0.2 B_2O_3-50.0 SiO_2) in the absence of osteogenic supplements. Both BaGs induced early osteogenic differentiation by increasing alkaline phosphatase activity (ALP) and the expression of osteogenic marker genes RUNX2a and OSTERIX. Based on ALP activity, the slower reacting 1-06 glass was a stronger osteoinducer. Regarding the cell attachment, cells cultured on BaGs had enhanced integrinβ1 and vinculin production, and mature focal adhesions were smaller but more dispersed than on cell culture plastic (polystyrene). Focal adhesion kinase (FAK), extracellular signal-regulated kinase (ERK1/2) and c-Jun N-terminal kinase (JNK)-induced c-Jun phosphorylations were upregulated by glass contact. Moreover, the BaG-stimulated osteoinduction was significantly reduced by FAK and mitogen-activated protein kinase (MAPK) inhibitors, indicating an important role for FAK and MAPKs in the BaG-induced early osteogenic commitment of hASCs. Upon indirect insert culture, the ions released from the BaG discs could not reproduce the observed cellular changes, which highlighted the role of direct cell-BaG interactions in the osteopotential of BaGs. These findings gave valuable insight into the mechanism of BaG-induced osteogenic differentiation and therefore provided knowledge to aid the future design of

new functional biomaterials to meet the increasing demand for clinical bone TE treatments.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Faculty of Biomedical Sciences and Engineering, The National Science Centre, Poland, Tampere University Hospital, Johan Gadolin Process Chemistry Centre, Abo Akademi University, University of Tampere
Contributors: Ojansivu, M., Wang, X., Hyväri, L., Kellomäki, M., Hupa, L., Vanhatupa, S., Miettinen, S.
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Publication date: 2018
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Journal: European Cells and Materials
Volume: 35
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Ratings:

Scopus rating (2018): CiteScore 6.4 SJR 1.171 SNIP 1.062
Original language: English
ASJC Scopus subject areas: Bioengineering, Biochemistry, Biomaterials, Biomedical Engineering, Cell Biology
Keywords: Bioactive glass, Cell attachment, Cell signalling, Focal adhesion, Mesenchymal stem cell, Mitogen-activated protein kinase, Osteogenic differentiation
DOIs:

10.22203/eCM.v035a05

Bibliographical note
EXT="Ojansivu, M."
EXT="Vanhatupa, S."
Source: Scopus
Source ID: 85052576307
Research output: Contribution to journal › Article › Scientific › peer-review

Effect of lactide monomer on the hydrolytic degradation and performance of melt processed poly(lactide-coglycolide) 85L/15G

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Department of Biomedical Engineering, Faculty of Biomedical Sciences and Engineering, Department of Business Information Management and Logistics, Biomateriaalitekniikka, Integrated Technologies for Tissue Engineering Research (ITTE), Bioretec Ltd.
Contributors: Paakinaho, K., Heino, H., Väisänen, J., Törmälä, P., Kellomäki, M.
Publication date: 2011

Host publication information
Title of host publication: 24th European Conference on Biomaterials - Annual Conference of the European Society for Biomaterials, ESB 2011
ASJC Scopus subject areas: Biomaterials
URLs:

http://www.scopus.com/inward/record.url?scp=84887012796&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84887012796
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Mathematical modelling of the action potential of human embryonic stem cell derived cardiomyocytes
Background: Human embryonic stem cell derived cardiomyocytes (hESC-CMs) hold high potential for basic and applied cardiovascular research. The development of a reliable simulation platform able to mimic the functional properties of hESC-CMs would be of considerable value to perform preliminary test complementing in vitro experimentations.Methods: We developed the first computational model of hESC-CM action potential by integrating our original electrophysiological recordings of transient-outward, funny, and sodium-calcium exchanger currents and data derived from literature on sodium, calcium and potassium currents in hESC-CMs.Results: The model is able to reproduce basal electrophysiological properties of hESC-CMs at 15 40 days of differentiation (Early stage). Moreover, the model reproduces the modifications occurring through the transition from Early to Late developmental stage (50-110, days of differentiation). After simulated blockade of ionic channels and pumps of the sarcoplasmic reticulum, Ca^{2+} transient amplitude was decreased by 12%

and 33% in Early and Late stage, respectively, suggesting a growing contribution of a functional reticulum during maturation. Finally, as a proof of concept, we tested the effects induced by prototypical channel blockers, namely E4031 and nickel, and their qualitative reproduction by the model.Conclusions: This study provides a novel modelling tool that may serve useful to investigate physiological properties of hESC-CMs.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Integrated Technologies for Tissue Engineering Research (ITTE), Biomedical Engineering Laboratory - D.E.I.S, University of Bologna, CNR-INO, University of Geneva
Contributors: Paci, M., Sartiani, L., Del Lungo, M., Jaconi, M., Mugelli, A., Cerbai, E., Severi, S.
Publication date: 28 Aug 2012
Peer-reviewed: Yes

Publication information
Journal: BioMedical Engineering Online
Volume: 11
Article number: 61
ISSN (Print): 1475-925X
Ratings:

Scopus rating (2012): CiteScore 2.8 SJR 0.467 SNIP 1.191
Original language: English
ASJC Scopus subject areas: Biomedical Engineering, Radiological and Ultrasound Technology, Radiology Nuclear Medicine and imaging, Biomaterials
Keywords: Action potential, Computer simulation, Embryonic stem cells, Pharmacology
DOIs:

10.1186/1475-925X-11-61
URLs:

http://www.scopus.com/inward/record.url?scp=84865344484&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84865344484
Research output: Contribution to journal › Article › Scientific › peer-review

Evaluation of scaffold microstructure and comparison of cell seeding methods using micro-computed tomography-based tools

Micro-computed tomography (micro-CT) provides a means to analyse and model three-dimensional (3D) tissue engineering scaffolds. This study proposes a set of micro-CT-based tools firstly for evaluating the microstructure of scaffolds and secondly for comparing different cell seeding methods. The pore size, porosity and pore interconnectivity of supercritical CO2 processed poly(l-lactide-co-ε-caprolactone) (PLCL) and PLCL/β-tricalcium phosphate scaffolds were analysed using computational micro-CT models. The models were supplemented with an experimental method, where iron-labelled microspheres were seeded into the scaffolds and micro-CT imaged to assess their infiltration into the scaffolds. After examining the scaffold architecture, human adipose-derived stem cells (hASCs) were seeded into the scaffolds using five different cell seeding methods. Cell viability, number and 3D distribution were evaluated. The distribution of the cells was analysed using micro-CT by labelling the hASCs with ultrasmall paramagnetic iron oxide nanoparticles. Among the tested seeding methods, a forced fluid flow-based technique resulted in an enhanced cell infiltration throughout the scaffolds compared with static seeding. The current study provides an excellent set of tools for the development of scaffolds and for the design of 3D cell culture experiments.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: BioMediTech, Research group: Biomaterials and Tissue Engineering Group, Research group: Computational Biophysics and Imaging Group, Orton Orthopaedic Hospital, Tampere University Hospital
Contributors: Palmroth, A., Pitkänen, S., Hannula, M., Paakinaho, K., Hyttinen, J., Miettinen, S., Kellomäki, M.
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Journal: Journal of the Royal Society. Interface
Volume: 17
Issue number: 165
Article number: 20200102
ISSN (Print): 1742-5689
Original language: English

ASJC Scopus subject areas: Biotechnology, Biophysics, Bioengineering, Biomaterials, Biochemistry, Biomedical Engineering
Keywords: cell seeding, micro-CT, microsphere, supercritical CO2 processing, tissue engineering, USPIO
DOIs:
10.1098/rsif.2020.0102

Bibliographical note
INT=bmte,"Miettinen, Susanna"
Research output: Contribution to journal › Article › Scientific › peer-review

Biomaterials for Electronics
Challenges of climate change, ecological scarcity and depletion of natural resources form a global push towards a bioeconomy, which means shifting from fossil to renewable raw materials. Wood biomass will likely get a significant role in the Finnish bioeconomy. Finnish economy has conventionally focused on bulk products, while the challenge in the future is to bring high added value to the fibre based components and products. Cellulose based nanomaterials are low-cost, strong, porous, lightweight, solution processable, biocompatible, biodegradable and piezoelectric biomaterials, which have obvious applications for example in biomedical and electronic applications.

Piezoelectric sensors are widely applicable for various healthcare and well-being applications. We have recently studied flexible piezoelectric sensors made from commercial PVDF films and printable PVDF-TrFE ink, as well as biodegradable films from wood-based cellulose nanofibrils (CNF) [1] and bacterial cellulose (BC).

The high porosity of CNF makes it also a promising material for supercapacitors, also known as electrochemical double-layer capacitors (EDLC). We have recently demonstrated the fabrication of supercapacitor electrodes from a mixture of CNF and dandelion using high temperature pyrolysis.

References:
[1] S. Rajala, T. Siponkoski, E. Sarlin, M. Mettänen, M. Vuoriluoto, A. Pammo, J. Juuti, O. J. Rojas, S. Franssila, and S. Tuukkanen. ”Cellulose nanofibril film as a piezoelectric sensor material”. ACS Appl. Mater. Interfaces 8(24) (2016) 15607.

General information
Publication status: Published
Organisations: Faculty of Biomedical Sciences and Engineering, Department of Automation Science and Engineering, Research area: Microsystems, Research area: Measurement Technology and Process Control, University of Twente, Faculty of Biomedical Sciences and Engineering, Tampere University of Technology
Contributors: Pammo, A., Schouten, M., Virtanen, J., Tuukkanen, S.
Number of pages: 1
Pages: 1-1
Publication date: 25 Nov 2016
Peer-reviewed: Unknown
Event:
ASJC Scopus subject areas: Biomaterials, Materials Science(all), Electrical and Electronic Engineering
Keywords: biomaterial, piezoelectric sensor, nanocellulose, bacterial cellulose, supercapacitor, PVDF-TrFE
Research output: Other conference contribution › Paper, poster or abstract › Scientific

Enhancement of adhesion and promotion of osteogenic differentiation of human adipose stem cells by poled electroactive poly(vinylidene fluoride)
Poly(vinylidene fluoride) (PVDF) is a biocompatible material with excellent electroactive properties. Nonelec-troactive α-PVDF and electroactive β-PVDF were used to investigate the substrate polarization and polarity influence on the focal adhesion (FA) size and number as well as on human adipose stem cells (hASCs) differentiation. hASCs were cultured on different PVDF surfaces adsorbed with fibronectin and FA size and number, total adhesion area, cell size, cell aspect ratio and FA density were estimated using cells expressing vinculin fused to enhanced green fluorescent protein. Osteogenic differentiation was also determined using a quantitative alkaline phosphatase assay. The surface charge of the poled PVDF films (positive or negative) influenced the hydrophobicity of the samples, leading to variations in the conformation of adsorbed extracellular matrix proteins, which ultimately modulated the stem cell adhesion on the films and induced their osteogenic differentiation.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: BioMediTech, Department of Physics, Integrated Technologies for Tissue Engineering Research (ITTE), Multi-scaled biodata analysis and modelling (MultiBAM), Fimlab Laboratories Ltd, Campus Do IPCA, Universidade do Minho, Instituto Politécnico Do Cávado e Do Ave
Contributors: Parssinen, J., Hammarén, H., Rahikainen, R., Sencadas, V., Ribeiro, C., Vanhatupa, S., Miettinen, S., Lanceros-Méndez, S., Hytönen, V. P.

Number of pages: 10
Pages: 919-928
Publication date: 1 Mar 2015
Peer-reviewed: Yes

Publication information
Journal: Journal of Biomedical Materials Research. Part A
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Issue number: 3
ISSN (Print): 1549-3296
Ratings:

Scopus rating (2015): CiteScore 6 SJR 1.028 SNIP 1.008
Original language: English
ASJC Scopus subject areas: Ceramics and Composites, Biomaterials, Biomedical Engineering, Metals and Alloys
Keywords: Cell adhesion, Electroactive polymer, Osteogenesis, Stem cell
DOIs:

10.1002/jbm.a.35234
URLs:

http://www.scopus.com/inward/record.url?scp=84922979785&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84922979785
Research output: Contribution to journal › Article › Scientific › peer-review

Novel osteoconductive β-tricalcium phosphate/poly(L-lactide-co-e-caprolactone) scaffold for bone regeneration: a study in a rabbit calvarial defect

The advantages of synthetic bone graft substitutes over autogenous bone grafts include abundant graft volume, lack of complications related to the graft harvesting, and shorter operation and recovery times for the patient. We studied a new synthetic supercritical CO_2 –processed porous composite scaffold of β-tricalcium phosphate and poly(L-lactide-co-caprolactone) copolymer as a bone graft substitute in a rabbit calvarial defect. Bilateral 12 mm diameter critical size calvarial defects were successfully created in 18 rabbits. The right defect was filled with a scaffold moistened with bone marrow aspirate, and the other was an empty control. The material was assessed for applicability during surgery. The follow-up times were 4, 12, and 24 weeks. Radiographic and micro-CT studies and histopathological analysis were used to evaluate new bone formation, tissue ingrowth, and biocompatibility. The scaffold was easy to shape and handle during the surgery, and the bone-scaffold contact was tight when visually evaluated after the implantation. The material showed good biocompatibility and its porosity enabled rapid invasion of vasculature and full thickness mesenchymal tissue ingrowth already at four weeks. By 24 weeks, full thickness bone ingrowth within the scaffold and along the dura was generally seen. In contrast, the empty defect had only a thin layer of new bone at 24 weeks. The radiodensity of the material was similar to the density of the intact bone. In conclusion, the new porous scaffold material, composed of microgranular β-TCP bound into the polymer matrix, proved to be a promising osteoconductive bone graft substitute with excellent handling properties. [Figure not available: see fulltext.].

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Electronics and Communications Engineering, Faculty of Biomedical Sciences and Engineering, Research group: Computational Biophysics and Imaging Group, Faculty of Veterinary Medicine, University of Helsinki, Orton Orthopaedic Hospital, Muonio Health Center
Contributors: Pihlman, H., Keränen, P., Paakinaho, K., Linden, J., Hannula, M., Manninen, I. K., Hyttinen, J., Manninen, M. , Laitinen-Vapaavuori, O.
Publication date: 1 Oct 2018
Peer-reviewed: Yes

Publication information
Journal: Journal of Materials Science: Materials in Medicine
Volume: 29
Issue number: 10
Article number: 156
ISSN (Print): 0957-4530
Ratings:

Scopus rating (2018): CiteScore 4.7 SJR 0.612 SNIP 0.855
Original language: English
ASJC Scopus subject areas: Biophysics, Bioengineering, Biomaterials, Biomedical Engineering
DOIs:

10.1007/s10856-018-6159-9

Source: Scopus
Source ID: 85054473480
Research output: Contribution to journal › Article › Scientific › peer-review

Characterisation and in vitro and in vivo evaluation of supercritical-CO2-foamed β-TCP/PLCL composites for bone applications

Most synthetic bone grafts are either hard and brittle ceramics or paste-like materials that differ in applicability from the gold standard autologous bone graft, which restricts their widespread use. Therefore, the aim of the study was to develop an elastic, highly porous and biodegradable β-tricalciumphosphate/poly(L-lactide-co-ε-caprolactone) (β-TCP/PLCL) composite for bone applications using supercritical CO2 foaming. Ability to support osteogenic differentiation was tested in human adipose stem cell (hASC) culture for 21 d. Biocompatibility was evaluated for 24 weeks in a rabbit femur-defect model. Foamed composites had a high ceramic content (50 wt%) and porosity (65-67 %). After 50 % compression, in an aqueous environment at 37 °C, tested samples returned to 95 % of their original height. Hydrolytic degradation of β-TCP/PLCL composite, during the 24-week follow-up, was very similar to that of porous PLCL scaffold both in vitro and in vivo. Osteogenic differentiation of hASCs was demonstrated by alkaline phosphatase activity analysis, alizarin red staining, soluble collagen analysis, immunocytochemical staining and qRT-PCR. In vitro, hASCs formed a pronounced mineralised collagen matrix. A rabbit femur defect model confirmed biocompatibility of the composite. According to histological Masson-Goldner's trichrome staining and micro-computed tomography, β-TCP/PLCL composite did not elicit infection, formation of fibrous capsule or cysts. Finally, native bone tissue at 4 weeks was already able to grow on and in the β-TCP/PLCL composite. The elastic and highly porous β-TCP/PLCL composite is a promising bone substitute because it is osteoconductive and easy-to-use and mould intraoperatively.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: BioMediTech
Contributors: Pitkänen, S., Paakinaho, K., Pihlman, H., Ahola, N., Hannula, M., Asikainen, S., Manninen, M., Morelius, M., Keränen, P., Hyttinen, J., Kellomäki, M., Laitinen-Vapaavuori, O., Miettinen, S.
Number of pages: 16
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Peer-reviewed: Yes

Publication information

Journal: European cells & materials
Volume: 38
ISSN (Print): 1473-2262
Ratings:

Scopus rating (2019): CiteScore 6 SJR 1.141 SNIP 1.069
Original language: English
ASJC Scopus subject areas: Bioengineering, Biochemistry, Biomaterials, Biomedical Engineering, Cell Biology
Electronic versions:

v038a04
DOIs:

10.22203/eCM.v038a04
URLs:

http://urn.fi/URN:NBN:fi:tuni-201909173355
Source: Scopus
Source ID: 85071152630
Research output: Contribution to journal › Article › Scientific › peer-review

Multi-stable dynamics of the non-adiabatic repressilator

The assumption of the fast binding of transcription factors (TFs) to promoters is a typical point in studies of synthetic genetic circuits functioning in bacteria. Although the assumption is effective for simplifying the models, it becomes questionable in the light of in vivo measurements of the times TF spends searching for its cognate DNA sites. We investigated the dynamics of the full idealized model of the paradigmatic genetic oscillator, the repressilator, using deterministic mathematical modelling and stochastic simulations. We found (using experimentally approved parameter values) that decreases in the TF binding rate changes the type of transition between steady state and oscillation. As a result, this gives rise to the hysteresis region in the parameter space, where both the steady state and the oscillation coexist. We further show that the hysteresis is persistent over a considerable range of the parameter values, but the presence of the oscillations is limited by the low rate of TF dimer degradation. Finally, the stochastic simulation of the model confirms the hysteresis with switching between the two attractors, resulting in highly skewed period distributions. Moreover, intrinsic noise stipulates trains of large-amplitude modulations around the stable steady state outside the hysteresis region, which makes the period distributions bimodal.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Mathematics, Research group: MAT Inverse Problems, Mathematical modelling with wide societal impact (MathImpact), Department of Theoretical Physics, Lebedev Physical Institution
Contributors: Potapov, I., Zhurov, B., Volkov, E.
Publication date: 6 Mar 2015
Peer-reviewed: Yes

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Journal: Journal of the Royal Society. Interface
Volume: 12
Issue number: 104
Article number: 20141315
ISSN (Print): 1742-5689
Ratings:

Scopus rating (2015): CiteScore 7.5 SJR 1.823 SNIP 1.554
Original language: English
ASJC Scopus subject areas: Biophysics, Biotechnology, Bioengineering, Biomedical Engineering, Biomaterials, Biochemistry
Keywords: Adiabatic, Bimodality, Genetic oscillator, Hysteresis, Multi-stability
DOIs:

10.1098/rsif.2014.1315
URLs:

http://www.scopus.com/inward/record.url?scp=84923240824&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84923240824
Research output: Contribution to journal › Article › Scientific › peer-review

Demonstration of increased lipid accumulation potential of stigeoclonium sp., Kütz. BUM11007 under nitrogen starved regime: A new source of lipids for biodiesel production

The fresh water microalga Stigeoclonium sp., Kütz. BUM11007 was investigated for their property to be a suitable candidate for biodiesel production. The growth, lipid content and fatty acid profiles of the organism were determined under both normal and nitrogen free conditions with Chu 10 medium. A maximum biomass concentration 2.84±0.11 g/l with lipid content 138.21±9.82 mg/g and lipid productivity 15.07±0.67 mg/l·d was obtained under nutrient sufficient condition. In contrast to which under nitrogen depleted regimes in a two phase culturing system, biomass yield 2.798±0.18 g/l with increased lipid content 407.18 ± 11.6 mg/g at lipid productivity 43.68 ± 1.82 mg/l · d were recorded. The fatty acid methyl ester profiles revealed the presence of 16:0 (palmitic), 18:0 (stearic), 18:1 (oleic) and 18:2 (linoleic) methyl esters as the major components. The results show the ability of the algae to be a promising feedstock source for biodiesel production.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Urban circular bioeconomy (UrCirBio), Bharathidasan University, Fisk University
Contributors: Praveenkumar, R., Johncy, K., MubarakAli, D., Vijayan, D., Thajuddin, N., Gunasekaran, M.
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ASJC Scopus subject areas: Biomaterials, Bioengineering, Renewable Energy, Sustainability and the Environment
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Halogen bonding versus hydrogen bonding in driving self-assembly and performance of light-responsive supramolecular polymers

Halogen bonding is arguably the least exploited among the many non-covalent interactions used in dictating molecular self-assembly. However, its directionality renders it unique compared to ubiquitous hydrogen bonding. Here, the role of this directionality in controlling the performance of light-responsive supramolecular polymers is highlighted. In particular, it is shown that light-induced surface patterning, a unique phenomenon occurring in azobenzene-containing polymers, is more efficient in halogen-bonded polymer-azobenzene complexes than in the analogous hydrogen-bonded complexes. A systematic study is performed on a series of azo dyes containing different halogen or hydrogen bonding donor moieties, complexed to poly(4-vinylpyridine) backbone. Through single-atom substitution of the bond-donor, control of both the strength and the nature of the noncovalent interaction between the azobenzene units and the polymer backbone is achieved. Importantly, such substitution does not significantly alter the electronic properties of the azobenzene units, hence providing us with unique tools in studying the structure-performance relationships in the light-induced surface deformation process. The results represent the first demonstration of light-responsive halogen-bonded polymer systems and also highlight the remarkable potential of halogen bonding in fundamental studies of photoresponsive azobenzene-containing polymers.

General information

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Organisations: Frontier Photonics, Tokyo Institute of Technology, Politecnico di Milano, Università degli Studi di Milano, Aalto University, VTT Technical Research Centre of Finland
Contributors: Priimagi, A., Cavallo, G., Forni, A., Gorynsztejn-Leben, M., Kaivola, M., Metrangolo, P., Milani, R., Shishido, A., Pilati, T., Resnati, G., Terraneo, G.
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Co-culture of human induced pluripotent stem cell-derived retinal pigment epithelial cells and endothelial cells on double collagen-coated honeycomb films

In vitro cell culture models representing the physiological and pathological features of the outer retina are urgently needed. Artificial tissue replacements for patients suffering from degenerative retinal diseases are similarly in great demand. Here, we developed a co-culture system based solely on the use of human induced pluripotent stem cell (hiPSC)-derived cells. For the first time, hiPSC-derived retinal pigment epithelium (RPE) and endothelial cells (EC) were cultured on opposite sides of porous polylactide substrates prepared by breath figures (BF), where both surfaces had been collagen-coated by Langmuir–Schaefer (LS) technology. Small modifications of casting conditions during material preparation allowed the production of free-standing materials with distinct porosity, wettability and ion diffusion capacity. Complete pore coverage was achieved by the collagen coating procedure, resulting in a detectable nanoscale topography. Primary retinal endothelial cells (ACBRI181) and umbilical cord vein endothelial cells (hUVEC) were utilised as EC references. Mono-cultures of all ECs were prepared for comparison. All tested materials supported cell attachment and growth. In mono-culture, properties of the materials had a major effect on the growth of all ECs. In co-culture, the presence of hiPSC-RPE affected the primary ECs more significantly than hiPSC-EC. In consistency, hiPSC-RPE were also less affected by hiPSC-EC than by the primary ECs. Finally, our results show that the modulation of the porosity of the materials can promote or prevent EC migration. In short, we showed that the behaviour of the cells is highly dependent on the three main variables of the study: the presence of a second cell type in co-culture, the source of endothelial cells and the biomaterial properties.

The combination of BF and LS methodologies is a powerful strategy to develop thin but stable materials enabling cell growth and modulation of cell-cell contact. Statement of significance: Artificial blood-retinal barriers (BRB), mimicking the interface at the back of the eye, are urgently needed as physiological and disease models, and for tissue transplantation targeting patients suffering from degenerative retinal diseases. Here, we developed a new co-culture model based on thin, biodegradable porous films, coated on both sides with collagen, one of the main components of the natural BRB, and cultivated endothelial and retinal pigment epithelial cells on opposite sides of the films, forming a three-layer structure. Importantly, our hiPSC-EC and hiPSC-RPE co-culture model is the first to exclusively use human induced pluripotent stem cells as cell source, which have been widely regarded as an practical candidate for therapeutic applications in regenerative medicine.

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Contributors: Rebelo Calejo, T., Vuorenpää, H., Vuorimaa-Laukkanen, E., Kallio, P., Aalto-Setälä, K., Miettinen, S., Skottman, H., Kellomäki, M., Juuti-Uusitalo, K.
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Bibliographical note
INT=BMTE,"Saari, Jaakko"
INT=BMTE,"Vuorenpää, Hanna"
INT=BMTE,"Aalto-Setälä, Katriina"
INT=BMTE,"Miettinen, Susanna"
INT=BMTE,"Skottman, Heli"
INT=BMTE,"Juuti-Uusitalo, Kati"
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Solvent Welding and Imprinting Cellulose Nanofiber Films Using Ionic Liquids

Cellulose nanofiber films (CNFF) were treated via a welding process using ionic liquids (ILs). Acid-base-conjugated ILs derived from 1,5-diazabicyclo[4.3.0]non-5-ene [DBN] and 1-ethyl-3-methylimidazolium acetate ([emim][OAc]) were utilized. The removal efficiency of ILs from welded CNFF was assessed using liquid-state nuclear magnetic resonance (NMR) spectroscopy and Fourier transform infrared spectroscopy (FTIR). The mechanical and physical properties of CNFF indicated surface plasticization of CNFF, which improved transparency. Upon treatment, the average CNFF toughness increased by 27%, and the films reached a Young's modulus of ~5.8 GPa. These first attempts for IL "welding" show promise to tune the surfaces of biobased films, expanding the scope of properties for the production of new biobased materials in a green chemistry context. The results of this work are highly relevant to the fabrication of CNFFs using ionic liquids and related solvents.

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Organisations: Materials Science, Research group: Paper Converting and Packaging, Universidad Del Bío-Bío, Aalto University
Contributors: Reyes, G., Borghei, M., King, A. W. T., Lahti, J., Rojas, O. J.
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Dynamic piezoelectric stimulation enhances osteogenic differentiation of human adipose stem cells
This work reports on the influence of the substrate polarization of electroactive β-poly(vinylidene fluoride) (β-PVDF) on human adipose stem cells (hASCs) differentiation under static and dynamic conditions. hASCs were cultured on different β-PVDF surfaces (non-poled and "poled -") adsorbed with fibronectin and osteogenic differentiation was determined using a quantitative alkaline phosphatase assay. "Poled -" β-PVDF samples promote higher osteogenic differentiation, which is even higher under dynamic conditions. It is thus demonstrated that electroactive membranes can provide the necessary electromechanical stimuli for the differentiation of specific cells and therefore will support the design of suitable tissue engineering strategies, such as bone tissue engineering.

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Organisations: Integrated Technologies for Tissue Engineering Research (ITTE), Multi-scaled biodata analysis and modelling (MultiBAM), INL - International Iberian Nanotechnology Laboratory, Fimlab Laboratories Ltd, Campus Do IPCA, Universidade do Minho, Instituto Politécnico Do Cávado e Do Ave
Contributors: Ribeiro, C., Pärssinen, J., Sencadas, V., Correia, V., Miettinen, S., Hytönen, V. P., Lanceros-Méndez, S.
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Original language: English
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Research output: Contribution to journal › Article › Scientific › peer-review

Gas-foamed poly(lactide-co-glycolide) and poly(lactide-co-glycolide) with bioactive glass fibres demonstrate insufficient bone repair in lapine osteochondral defects

Deep osteochondral defects may leave voids in the subchondral bone, increasing the risk of joint structure collapse. To ensure a stable foundation for the cartilage repair, bone grafts can be used for filling these defects. Poly(lactide-co-glycolide) (PLGA) is a biodegradable material that improves bone healing and supports bone matrix deposition. We compared the reparative capacity of two investigative macroporous PLGA-based biomaterials with two commercially available bone graft substitutes in the bony part of an intra-articular bone defect created in the lapine femur. New Zealand white rabbits (n = 40) were randomized into five groups. The defects, 4 mm in diameter and 8 mm deep, were filled with neat PLGA; a composite material combining PLGA and bioactive glass fibres (PLGA–BGf); commercial beta-tricalcium phosphate (β-TCP) granules; or commercial bioactive glass (BG) granules. The fifth group was left untreated for spontaneous repair. After three months, the repair tissue was evaluated with X-ray microtomography and histology. Relative values comparing the operated knee with its contralateral control were calculated. The relative bone volume fraction (ΔBV/TV) was largest in the β-TCP group ($p \leq 0.012$), which also showed the most abundant osteoid. BG resulted in improved bone formation, whereas defects in the PLGA–BGf group were filled with fibrous tissue. Repair with PLGA did not differ from spontaneous repair. The PLGA, PLGA–BGf, and spontaneous groups showed thicker and sparser trabeculae than the commercial controls. We conclude that bone repair with β-TCP and BG granules was satisfactory, whereas the investigational PLGA-based materials were only as good as or worse than spontaneous repair.

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Organisations: BioMediTech, University of Helsinki Faculty of Medicine, Helsinki University Central Hospital, Department of Medical Physics, Tampere University Hospital, Abo Akad Univ, Abo Akademi University, Dept Phys
Contributors: Salonius, E., Muhonen, V., Lehto, K., Järvinen, E., Pyhältö, T., Hannula, M., Aula, A. S., Uppstu, P., Haaparanta, A. M., Rosling, A., Kellomäki, M., Kiviranta, I.
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ASJC Scopus subject areas: Medicine (miscellaneous), Biomaterials, Biomedical Engineering
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Human adipose tissue extract induces angiogenesis and adipogenesis in vitro

The induction of adequate vascularization, a major challenge in tissue engineering, has been tried with numerous methods but with unsatisfactory results. Adipose tissue, an active endocrine organ with dense vasculature, secretes a wide number of angiogenic and adipogenic factors and seems an attractive source for these bioactive factors. We produced a novel cell-free extract from mature human adipose tissue (adipose tissue extract [ATE]) and analyzed the ability of this extract to induce angiogenesis and adipogenesis in vitro and studied the cytokine and growth factor composition of ATE with ELISA and cytokine array. We demonstrate that ATE, when added as cell culture supplement, effectively induced triglyceride accumulation in human adipose stem cells at concentrations from 200 μg/mL upward in less than a week and caused elevated levels of adipocyte differentiation markers (proliferator-activated receptor gamma and acyl-CoA-binding protein) when treated with at least 350 μg/mL of ATE. ATE induced angiogenesis from 450 μg/mL upward after a week in vitro. ATE contained numerous angiogenic and adipogenic factors, for example, vascular endothelial growth factor, basic fibroblast growth factor, interleukin-6, adiponectin, angiogenin, leptin, and insulin-like growth factor-I, as well as lower levels of a wide variety of other cytokines. We here present a novel cell-free angiogenesis-and adipogenesis-inducing agent that is cell-free and easy to produce, and its effect is dose dependent and its composition can be easily modified. Therefore, ATE is a promising novel agent to be used for angiogenesis induction to overcome the challenge of vascularization and for adipogenesis induction in a wide variety of tissue engineering applications in vitro and in vivo. ATE is also efficient for reproduction and modeling of natural adipogenesis in vitro for, for example, obesity and diabetes studies.

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Organisations: Integrated Technologies for Tissue Engineering Research (ITTE), Tampere University Hospital, University of Tampere, Medical School, BioMediTech
Contributors: Sarkanen, J. R., Kaila, V., Mannerström, B., Räty, S., Kuokkanen, H., Miettinen, S., Ylikomi, T.
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ASJC Scopus subject areas: Bioengineering, Biochemistry, Biomedical Engineering, Biomaterials, Medicine(all)
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Source ID: 84855405319
Research output: Contribution to journal › Article › Scientific › peer-review

Effect of incorporation of CdS NPs on performance of PTB7: PCBM organic solar cells
It has been well known that incorporation of nano-heterostructures of various metals, semiconductors and dielectric materials in the active layer of organic solar cells (OSCs) helps in improving power conversion efficiency (PCE). In the present study, we demonstrated microwave synthesis of CdS nanoparticles (NPs) for their application in one of most efficient OSCs consisting of poly[[4,8-bis[(2-ethylhexyl)oxy]benzo[1,2-b:4,5-b′]dithiophene-2,6-diyl] [3-fluoro-2-[(2-ethylhexyl)carbonyl] thieno[3,4-b]thiophenediyl]] (PTB7): [6,6]-phenyl C_{71}-butyric acid methyl ester (PCBM) photoactive blend. This is crucial to fully explore the promising features of low cost and scalability in organic-inorganic hybrid solar cells. Synthesized CdS NPs are slightly elongated and highly crystalline with their absorption lies in the visible region as confirmed by High resolution transmission electron microscopy (HRTEM), X-ray diffraction (XRD), UV-Vis absorption spectroscopy studies. Our experimental results for the devices in an inverted geometry having a structure ITO/ZnO/PTB7: CdS: PCBM/MoO_3/Ag has shown increase in Jsc and PCE by nearly 10%. However, it was observed that this increase is only when NPs were added in the low concentration in active layer. UV-Vis absorption spectroscopy, Photoluminescence (PL) and atomic force microscopy (AFM) studies were carried out in order understand the device performance.

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Contributors: Sharma, R., Bhalerao, S., Gupta, D.
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ASJC Scopus subject areas: Electronic, Optical and Magnetic Materials, Biomaterials, Chemistry(all), Condensed Matter Physics, Materials Chemistry, Electrical and Electronic Engineering
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Research output: Contribution to journal › Article › Scientific › peer-review

Biomimetic collagen I and IV double layer Langmuir-Schaefer films asmicroenvironment for human pluripotent stem cell derived retinal pigment epithelial cells

The environmental cues received by the cells from synthetic substrates invitro are very different from those they receive invivo. In this study, we applied the Langmuir-Schaefer (LS) deposition, a variant of Langmuir-Blodgett technique, to fabricate a biomimetic microenvironment mimicking the structure and organization of native Bruch's membrane for the production of the functional human embryonic stem cell derived retinal pigment epithelial (hESC-RPE) cells. Surface pressure-area isotherms were measured simultaneously with Brewster angle microscopy to investigate the self-assembly of human collagens type I and IV on air-subphase interface. Furthermore, the structure of the prepared collagen LS films was characterized with scanning electron microscopy, atomic force microscopy, surface plasmon resonance measurements and immunofluorescent staining. The integrity of hESC-RPE on double layer LS films was investigated by measuring transepithelial resistance and permeability of small molecular weight substance. Maturation and functionality of hESC-RPE cells on double layer collagen LS films was further assessed by RPE-specific gene and protein expression, growth factor secretion, and phagocytic activity. Here, we demonstrated that the prepared collagen LS films have layered structure with oriented fibers corresponding to architecture of the uppermost layers of Bruch's membrane and result in increased barrier properties and functionality of hESC-RPE cells as compared to the commonly used dip-coated controls.

General information

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Organisations: Department of Chemistry and Bioengineering, Research group: Supramolecular photochemistry, Tampere University of Technology, BioMediTech, Frontier Photonics, Integrated Technologies for Tissue Engineering Research (ITTE), Aalto University, BioMediTech, Univ Tampere, University of Tampere, BioMediTech, BMT FM5, Centre for Drug Research, Faculty of Pharmacy, Helsinki University, Department of Forest Products Technology, School of Chemical Technology, Division of Biopharmaceutical Sciences
Contributors: Sorkio, A. E., Vuorimaa-Laukkanen, E. P., Hakola, H. M., Liang, H., Ujula, T. A., Valle-Delgado, J. J., Österberg, M., Yliperttula, M. L., Skottman, H.
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Research output: Contribution to journal › Article › Scientific › peer-review

Surface Modified Biodegradable Electrospun Membranes as a Carrier for Human Embryonic Stem Cell-Derived Retinal Pigment Epithelial Cells

Human embryonic stem cell-derived retinal pigment epithelial (hESC-RPE) cells are currently undergoing clinical trials to treat retinal degenerative diseases. Transplantation of hESC-RPE cells in conjuction with a supportive biomaterial carrier holds great potential as a future treatment for retinal degeneration. However, there has been no such biodegradable material that could support the growth and maturation of hESC-RPE cells so far. The primary aim of this work was to create a thin porous poly (L-lactide-co-caprolactone) (PLCL) membrane that could promote attachment, proliferation, and maturation of the hESC-RPE cells in serum-free culture conditions. The PLCL membranes were modified by atmospheric pressure plasma processing and coated with collagen IV to enhance cell growth and maturation. Permeability of the membranes was analyzed with an Ussing chamber system. Analysis with scanning electron microscopy, contact angle measurement, atomic force microscopy, and X-ray photoelectron spectroscopy demonstrated that plasma surface treatment augments the surface properties of the membrane, which enhances the binding and conformation of the protein.

Cell proliferation assays, reverse transcription-polymerase chain reaction, indirect immunofluoresence staining, trans-epithelial electrical resistance measurements, and in vitro phagocytosis assay clearly demonstrated that the plasma treated PLCL membranes supported the adherence, proliferation, maturation and functionality of hESC-RPE cells in serum-free culture conditions. Here, we report for the first time, how PLCL membranes can be modified with atmospheric pressure plasma processing to enable the formation of a functional hESC-RPE monolayer on a porous biodegradable substrate, which have a potential as a tissue-engineered construct for regenerative retinal repair applications.

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Organisations: Integrated Technologies for Tissue Engineering Research (ITTE), University of Ulster
Contributors: Sorkio, A., Porter, P. J., Juuti-Uusitalo, K., Meenan, B. J., Skottman, H., Burke, G. A.
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Research output: Contribution to journal › Article › Scientific › peer-review

Structure and barrier properties of human embryonic stem cell-derived retinal pigment epithelial cells are affected by extracellular matrix protein coating
Extracellular matrix (ECM) interactions play a vital role in cell morphology, migration, proliferation, and differentiation of cells. We investigated the role of ECM proteins on the structure and function of human embryonic stem cell-derived retinal pigment epithelial (hESC-RPE) cells during their differentiation and maturation from hESCs into RPE cells in adherent differentiation cultures on several human ECM proteins found in native human Bruch's membrane, namely, collagen I, collagen IV, laminin, fibronectin, and vitronectin, as well as on commercial substrates of xeno-free CELLstart™ and Matrigel™. Cell pigmentation, expression of RPE-specific proteins, fine structure, as well as the production of basal lamina by hESC-RPE on different protein coatings were evaluated after 140 days of differentiation. The integrity of hESC-RPE epithelium and barrier properties on different coatings were investigated by measuring transepithelial resistance. All coatings supported the differentiation of hESC-RPE cells as demonstrated by early onset of cell pigmentation and further maturation to RPE monolayers after enrichment. Mature RPE phenotype was verified by RPE-specific gene and protein expression, correct epithelial polarization, and phagocytic activity. Significant differences were found in the degree of RPE cell pigmentation and tightness of epithelial barrier between different coatings. Further, the thickness of self-assembled basal lamina and secretion of the key ECM proteins found in the basement membrane of the native RPE varied between hESC-RPE cultured on compared protein coatings. In conclusion, this study shows that the cell culture substrate has a major effect on the structure and basal lamina production during the differentiation and maturation of hESC-RPE potentially influencing the success of cell integrations and survival after cell transplantation.

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Contributors: Sorkio, A., Hongisto, H., Kaarniranta, K., Uusitalo, H., Juuti-Uusitalo, K., Skottman, H.
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Wear resistance of nanoparticle coatings on paperboard

• LFS-deposited TiO_2 and SiO_2 nanoparticles create superhydro-phobic and hydrophilic paper surface, • Abrasive damage of surface structure influences only slightly the wettability of superhydrophobic TiO_2 and hydrophilic SiO_2 coatings, • A more severe abrasive action will remove some of the nanoparticle coating, but the hydrophobic/hydrophilic properties of the surface are maintained, • SiO_2 nanoparticle coated surface is more resistant to abrasion than the TiO_2 coating, which indicates a stronger inter-particle and particle to surface adhesion of the former, • Investigation of nanoparticle loss from the paper surface is challenging, due to the small total mass of nanoparticles in the coating, mixed together with pigment particles and fiber debris removed during abrasion experiment.

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Contributors: Stepien, M., Chinga-Carrasco, G., Saarinen, J. J., Teisala, H., Tuominen, M., Aromaa, M., Haapanen, J., Kuusipalo, J., Mäkelä, J. M., Toivakka, M.
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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Stimuli-Responsive Materials Based on Interpenetrating Polymer Liquid Crystal Hydrogels

Stimuli-responsive materials based on interpenetrating liquid crystal-hydrogel polymer networks are fabricated. These materials consist of a cholesteric liquid crystalline network that reflects color and an interwoven poly(acrylic acid) network that provides a humidity and pH response. The volume change in the cross-linked hydrogel polymer results in a dimensional alteration in the cholesteric network as well, which, in turn, leads to a color change yielding a dual-responsive photonic material. Furthermore a patterned coating having responsive and static interpenetrating polymer network areas is produced that changes both its surface topography and color.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Eindhoven University of Technology, School of Mathematical Sciences
Contributors: Stumpel, J. E., Gil, E. R., Spoelstra, A. B., Bastiaansen, C. W. M., Broer, D. J., Schenning, A. P. H. J.
Pages: 3314–3320
Publication date: 2015

Peer-reviewed: Yes

Publication information
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Original language: English
ASJC Scopus subject areas: Biomaterials, Electrochemistry, Condensed Matter Physics, Electronic, Optical and Magnetic Materials
Keywords: Cholesteric liquid crystals, Hydrogels, Interpenetrating polymer networks, Photonic materials, Smart materials
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URLs:

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Research output: Contribution to journal › Article › Scientific › peer-review

Osteogenic medium is superior to growth factors in differentiation of human adipose stem cells towards boneforming cells in 3D culture
Human adipose stem cells (hASCs) have been recently used to treat bone defects in clinical practice. Yet there is a need for more optimal scaffolds and cost-effective approaches to induce osteogenic differentiation of hASCs. Therefore, we compared the efficiency of bone morphogenetic proteins (BMP-2 and BMP-7), vascular endothelial growth factor (VEGF), and osteogenic medium (OM) for the osteo-induction of hASCs in 3D culture. In addition, growth factors were tested in combination with OM. Commercially available bioactive glass scaffolds (BioRestore) and biphasic calcium phosphate granules (BoneCeramic) were evaluated as prospective carriers for hASCs. Both biomaterials supported hASC-viability, but BioRestore resulted in higher cell number than BoneCeramic, whereas BoneCeramic supported more significant collagen production. The most efficient osteo-induction was achieved with plain OM, promoting higher alkaline phosphatase activity and collagen production than growth factors. In fact, treatment with BMP-2 or VEGF did not increase osteogenic differentiation or cell number significantly more than maintenance medium with either biomaterial. Moreover, BMP-7 treatment consistently inhibited proliferation and osteogenic differentiation of hASCs. Interestingly, there was no benefit from growth factors added to OM. This is the first study to demonstrate that OM enhances hASC-differentiation towards bone-forming cells significantly more than growth factors in 3D culture.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Integrated Technologies for Tissue Engineering Research (ITTE), Tampere University Hospital, University of Twente, BioMediTech, Onbone Oy, Univ of Oulu
Contributors: Tirkkonen, L., Haimi, S., Huttunen, S., Wolff, J., Pirhonen, E., Sándor, G. K., Miettinen, S.
Number of pages: 15
Pages: 144-158
Publication date: 2012
Peer-reviewed: Yes

Publication information
Journal: European Cells and Materials
Volume: 25
ISSN (Print): 1473-2262
Ratings:

Scopus rating (2012): CiteScore 0.9 SJR 0.294 SNIP 0.183
Original language: English
ASJC Scopus subject areas: Biochemistry, Cell Biology, Bioengineering, Biomedical Engineering, Biomaterials, Medicine(all)
Keywords: 3D scaffolds, Adipose stem cells, Bioactive glass, Biphasic calcium phosphate, Bone tissue engineering, Growth factors, In vitro culture, Mesenchymal stem cells, Osteogenic differentiation
URLs:

http://www.scopus.com/inward/record.url?scp=84878388600&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84878388600
Research output: Contribution to journal › Article › Scientific › peer-review

Human Neural Tissues from Neural Stem Cells Using Conductive Biogel and Printed Polymer Microelectrode Arrays for 3D Electrical Stimulation

Electricity is important in the physiology and development of human tissues such as embryonic and fetal development, and tissue regeneration for wound healing. Accordingly, electrical stimulation (ES) is increasingly being applied to influence cell behavior and function for a biomimetic approach to in vitro cell culture and tissue engineering. Here, the application of conductive polymer (CP) poly(3,4-ethylenedioxythiophene)-polystyrenesulfonate (PEDOT:PSS) pillars is described, direct-write printed in an array format, for 3D ES of maturing neural tissues that are derived from human neural stem cells (NSCs). NSCs are initially encapsulated within a conductive polysaccharide-based biogel interfaced with the CP pillar microelectrode arrays (MEAs), followed by differentiation in situ to neurons and supporting neuroglia during stimulation. Electrochemical properties of the pillar electrodes and the biogel support their electrical performance. Remarkably, stimulated constructs are characterized by widespread tracts of high-density mature neurons and enhanced maturation of functional neural networks. Formation of tissues using the 3D MEAs substantiates the platform for advanced clinically relevant neural tissue induction, with the system likely amendable to diverse cell types to create other neural and non-neural tissues. The platform may be useful for both research and translation, including modeling tissue development, function and dysfunction, electroceuticals, drug screening, and regenerative medicine.

General information

Publication status: E-pub ahead of print
MoE publication type: A1 Journal article-refereed
Organisations: Research group: Computational Biophysics and Imaging Group, BioMediTech, University of Wollongong, The University of Auckland, Department of Chemistry and Bioengineering, MacDiarmid Institute for Advanced Materials and Nanotechnology, University of Melbourne
Contributors: Tomaskovic-Crook, E., Zhang, P., Ahtiainen, A., Kaisvuo, H., Lee, C. Y., Beirne, S., Aqrawe, Z., Svirskis, D., Hyttinen, J., Wallace, G. G., Travas-Sejdic, J., Crook, J. M.
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Journal: ADVANCED HEALTHCARE MATERIALS
Article number: 1900425
ISSN (Print): 2192-2640
Ratings:

Scopus rating (2019): CiteScore 10.8 SJR 2.135 SNIP 1.251
Original language: English
ASJC Scopus subject areas: Biomaterials, Biomedical Engineering, Pharmaceutical Science
Keywords: 3D electrical stimulation, conductive biogels, human neural tissue, printed conducting polymer electrodes, stem cells
DOIs:

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Research output: Contribution to journal › Article › Scientific › peer-review

Direct laser writing of microstructures for the growth guidance of human pluripotent stem cell derived neuronal cells

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Research group: Biomaterials and Tissue Engineering Group, Integrated Technologies for Tissue Engineering Research (ITTE)
Contributors: Turunen, S., Käpylä, E., Lähteenmäki, M., Ylä-Outinen, L., Narkilahti, S., Kellomäki, M.
Number of pages: 8
Pages: 197-204
Publication date: 2014
Peer-reviewed: Yes

Publication information

Journal: Optics and Lasers in Engineering
Volume: 55
ISSN (Print): 0143-8166
Ratings:

Scopus rating (2014): CiteScore 4.1 SJR 0.964 SNIP 2.016
Original language: English
ASJC Scopus subject areas: Biomaterials
DOIs:

10.1016/j.optlaseng.2013.11.003

Bibliographical note
Contribution: organisation=elt,FACT1=1
Portfolio EDEND: 2014-02-15
Publisher name: Elsevier
Source: researchoutputwizard
Source ID: 1662
Research output: Contribution to journal › Article › Scientific › peer-review

Backscattering-based wireless communication and power transfer to small biomedical implants
In this paper and presentation, we will focus on different aspects of backscattering-based wireless communication and power transfer to small biomedical implants. We will present three different antenna topologies for data and power transfer through tissue, in vitro and in vivo studies on implantable intracranial pressure (ICP) sensors and give insight and analysis on wireless link reliability in tissue environment. We will also present radio frequency identification (RFID)-based implant platform and communication method. Moreover, we will focus on differences and challenges of in vivo environment compared to laboratory phantoms and tissue models. In our studies, different types of implantable antennas have been tested to investigate reliability, accuracy and sensitivity of the brain implants: A hybrid near field-far field system with a piezoresistive sensor for ICP monitoring [2], [4], a UHF band spilt-ring resonator system [3] and LC tank based miniature implantable antenna [5]. This paper will present these implant antennas and wireless power transfer in tissue environment present in human head.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: BioMediTech, Research group: Wireless Identification and Sensing Systems Research Group
Contributors: Ukkonen, L., Sydänheimo, L., Ma, S., Björninen, T.
Publication date: 2020

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ASJC Scopus subject areas: Electronic, Optical and Magnetic Materials, Biomaterials, Atomic and Molecular Physics, and Optics, Radiology Nuclear Medicine and imaging
Keywords: implant antennas, Wireless biomedical implants, wireless power transfer
DOIs:

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Source: Scopus
Source ID: 85082726318
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Nano-structured optical fibers made of glass-ceramics, and phase separated and metallic particle-containing glasses
For years, scientists have been looking for different techniques to make glasses perfect: fully amorphous and ideally homogeneous. Meanwhile, recent advances in the development of particle-containing glasses (PCG), defined in this paper as glass-ceramics, glasses doped with metallic nanoparticles, and phase-separated glasses show that these "imperfect" glasses can result in better optical materials if particles of desired chemistry, size, and shape are present in the glass. It has been shown that PCGs can be used for the fabrication of nanostructured fibers-a novel class of media for fiber optics. These unique optical fibers are able to outperform their traditional glass counterparts in terms of available emission spectral range, quantum effciency, non-linear properties, fabricated sensors sensitivity, and other parameters. Being rather special, nanostructured fibers require new, unconventional solutions on the materials used, fabrication, and characterization techniques, limiting the use of these novel materials. This work overviews practical aspects and progress in the fabrication and characterization methods of the particle-containing glasses with particular attention to nanostructured fibers made of these materials. A review of the recent achievements shows that current technologies allow producing high-optical quality PCG-fibers of different types, and the unique optical properties of these nanostructured fibers make them prospective for applications in lasers, optical communications, medicine, lighting, and other areas of

science and industry.

General information
Publication status: Published
MoE publication type: A2 Review article in a scientific journal
Organisations: Physics, Research group: Photonics Glasses, Université Côte d'Azur, Ecole Centrale de Nantes, PSL Research University
Contributors: Veber, A., Lu, Z., Vermillac, M., Pigeonneau, F., Blanc, W., Petit, L.
Number of pages: 29
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Peer-reviewed: Yes

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Journal: Fibers
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Ratings:

Scopus rating (2019): CiteScore 2.7 SJR 0.442 SNIP 1.036
Original language: English
ASJC Scopus subject areas: Ceramics and Composites, Civil and Structural Engineering, Biomaterials, Mechanics of Materials
Keywords: Fabrication, Glass, Glass-ceramics, Metallic nanoparticles, Optical fibers, Optical properties, Phase-separation
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Source: Scopus
Source ID: 85076893292
Research output: Contribution to journal › Review Article › Scientific › peer-review

Comparison of three light doses in the photodynamic treatment of actinic keratosis using mathematical modeling

Photodynamic therapy (PDT) is an emerging treatment modality for various diseases, especially for cancer therapy. Although high efficacy is demonstrated for PDT using standardized protocols in nonhyperkeratotic actinic keratoses, alternative light doses expected to increase efficiency, to reduce adverse effects or to expand the use of PDT, are still being evaluated and refined. We propose a comparison of the three most common light doses in the treatment of actinic keratosis with 5-aminolevulinic acid PDT through mathematical modeling. The proposed model is based on an iterative procedure that involves determination of the local fluence rate, updating of the local optical properties, and estimation of the local damage induced by the therapy. This model was applied on a simplified skin sample model including an actinic keratosis lesion, with three different light doses (red light dose, 37 J/cm^2, 75 mW/cm^2, 500 s; blue light dose, 10 J/cm^2, 10 mW/cm^2, 1000 s; and daylight dose, 9000 s). Results analysis shows that the three studied light doses, although all efficient, lead to variable local damage. Defining reference damage enables the nonoptimal parameters for the current light doses to be refined and the treatment to be more suitable

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Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Frontier Photonics, Univ Paris 06, Centre National de la Recherche Scientifique (CNRS), Pierre & Marie Curie University - Paris 6, Institut de Recherche pour le Developpement (IRD), Inria, Institut National de la Sante et de la Recherche Medicale (Inserm), Univ Sorbonne, CNRS,ICM,UMR S 1127,UMR 7225,U1127, INSERM,Inria Paris Rocquencourt,Inst Cerveau & Mo, Univ Lille Nord de France, Lille University Hospital - CHRU
Contributors: Vignion-Dewalle, A. S., Betrouni, N., Tylcz, J. B., Vermandel, M., Mortier, L., Mordon, S.
Publication date: 1 May 2015
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Article number: 058001
ISSN (Print): 1083-3668
Ratings:

Scopus rating (2015): CiteScore 5.3 SJR 1.173 SNIP 1.276

Original language: English
ASJC Scopus subject areas: Electronic, Optical and Magnetic Materials, Atomic and Molecular Physics, and Optics, Biomaterials, Biomedical Engineering
Keywords: light doses comparison, mathematical modeling, photodynamic therapy, protoporphyrin IX
DOIs:

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Source: Scopus
Source ID: 84930001957
Research output: Contribution to journal › Article › Scientific › peer-review

Noise measurements from reconstructed digital breast tomosynthesis

In this work, we investigated and measured the noise in Digital Breast Tomosynthesis (DBT) slices considering the back-projection (BP) algorithm for image reconstruction. First, we presented our open-source DBT reconstruction toolbox and validated with a freely available virtual clinical trials (VCT) software, comparing our results with the reconstruction toolbox available at the Food and Drug Administration's (FDA) repository. A virtual anthropomorphic breast phantom was generated in the VCT environment and noise-free DBT projections were simulated. Slices were reconstructed by both toolboxes and objective metrics were measured to evaluate the performance of our in-house reconstruction software. For the noise analysis, commercial DBT systems from two vendors were used to obtain x-ray projections of a uniform polymethyl methacrylate (PMMA) physical phantom. One system featured an indirect thallium activated cesium iodide (CsI(Tl)) scintillator detector and the other a direct amorphous selenium (a-Se) detector. Our in-house software was used to reconstruct raw projections into tomographic slices, and the mean pixel value, noise variance, signal-to-noise ratio (SNR) and the normalized noise power spectrum (NNPS) were measured. In addition, we investigated the adequacy of a heteroskedastic Gaussian model, with an affine variance function, to describe the noise in the reconstruction domain. The measurements show that the variance and SNR from reconstructed slices report similar spatial and signal dependency from previously reported in the projection domain. NNPS showed that the reconstruction process correlates the noise of the DBT slices in the case of projections degraded with almost uncorrelated noise.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Computing Sciences, University of São Paulo, Pio XII Foundation, University of Pennsylvania
Contributors: Vimieiro, R. B., Borges, L. R., Caron, R. F., Barufaldi, B., Bakic, P. R., Maidment, A. D., Vieira, M. A.
Publication date: 1 Mar 2019

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Publisher: SPIE, IEEE
Editors: Schmidt, T. G., Chen, G., Bosmans, H.
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Publication series

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ISSN (Print): 1605-7422
ASJC Scopus subject areas: Electronic, Optical and Magnetic Materials, Biomaterials, Atomic and Molecular Physics, and Optics, Radiology Nuclear Medicine and imaging
Keywords: Back-projection, Digital breast tomosynthesis, Image reconstruction, Noise measurements, Virtual clinical trials
DOIs:

10.1117/12.2512977
Source: Scopus
Source ID: 85068400087
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

The effect of equiaxial stretching on the osteogenic differentiation and mechanical properties of human adipose stem cells

Although mechanical cues are known to affect stem cell fate and mechanobiology, the significance of such stimuli on the osteogenic differentiation of human adipose stem cells (hASCs) remains unclear. In this study, we investigated the effect of long-term mechanical stimulation on the attachment, osteogenic differentiation and mechanical properties of hASCs. Tailor-made, pneumatic cell stretching devices were used to expose hASCs to cyclic equiaxial stretching in osteogenic medium. Cell attachment and focal adhesions were visualised using immunocytochemical vinculin staining on days 3 and 6, and the proliferation and alkaline phosphatase activity, as a sign of early osteogenic differentiation, were analysed on days 0, 6 and 10. Furthermore, the mechanical properties of hASCs, in terms of apparent Young's modulus and normalised contractility, were obtained using a combination of atomic force microscopy based indentation and

computational approaches. Our results indicated that cyclic equiaxial stretching delayed proliferation and promoted osteogenic differentiation of hASCs. Stretching also reduced cell size and intensified focal adhesions and actin cytoskeleton. Moreover, cell stiffening was observed during osteogenic differentiation and especially under mechanical stimulation. These results suggest that cyclic equiaxial stretching modifies cell morphology, focal adhesion formation and mechanical properties of hASCs. This could be exploited to enhance osteogenic differentiation.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Faculty of Biomedical Sciences and Engineering, Research area: Measurement Technology and Process Control, Research group: Micro and Nanosystems Research Group, BioMediTech, Tampere University Hospital, Biomechanics Research Centre, Natl. University of Ireland, Galway, Tampere Univ Technol, Tampere University of Technology, Dept Biomed Engn
Contributors: Virjula, S., Zhao, F., Leivo, J., Vanhatupa, S., Kreutzer, J., Vaughan, T. J., Honkala, A. M., Viehrig, M., Mullen, C. A., Kallio, P., McNamara, L. M., Miettinen, S.
Number of pages: 11
Pages: 38-48
Publication date: 1 Aug 2017
Peer-reviewed: Yes

Publication information

Journal: Journal of the Mechanical Behavior of Biomedical Materials
Volume: 72
ISSN (Print): 1751-6161
Ratings:

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Original language: English
ASJC Scopus subject areas: Biomaterials, Biomedical Engineering, Mechanics of Materials
Keywords: Atomic force microscopy indentation, Dynamic cell culture, Mechanical stimulation, mechanobiology, Mesenchymal stem cell, PDMS
DOIs:

10.1016/j.jmbbm.2017.04.016

Bibliographical note

EXT="Zhao, Feihu"
INT=tut-bmt,"Viehrig, Marlitt"
Source: Scopus
Source ID: 85018593351
Research output: Contribution to journal › Article › Scientific › peer-review

Multi-material bio-printing facilities

Dispenser printing provides a method to produce 2D and 3D patterns from basically any liquid phase material. Dispensing considered here is a form of extrusion of material through a narrow diameter needle. An advantage of dispensing technique over conventional printing techniques is the avoidance of complicated ink formulation, which generally requires hazardous organic solvents that may be harmful to biological objects. Dispensing also allows materials with rather different properties such as different viscosity to be printed in the same process. Combining the dispensing printing of liquid phase materials and 3D printing of solid materials, complex structures with new functional properties can be fabricated, which is very challenging if not impossible using conventional manufacturing techniques.

General information

Publication status: Published
Organisations: Faculty of Biomedical Sciences and Engineering, Research group: Sensor Technology and Biomeasurements (STB), Research group: Nanoscale Phenomena and Measurements (NPM)
Contributors: Virtanen, J., Tuukkanen, S.
Number of pages: 1
Publication date: 26 Oct 2017
Peer-reviewed: Unknown
Event: Paper presented at BMT and MED Research Day 2017, Tampere, Finland.
ASJC Scopus subject areas: Biomaterials
Research output: Other conference contribution › Paper, poster or abstract › Scientific

Human Adipose Stem Cells Differentiated on Braided Polylactide Scaffolds is a Potential Approach for Tendon Tissue Engineering

Growing number of musculoskeletal defects increases the demand for engineered tendon. Our aim was to find an efficient strategy to produce tendon-like matrix in vitro. To allow efficient differentiation of human adipose stem cells (hASCs) toward tendon tissue, we tested different medium compositions, biomaterials, and scaffold structures in preliminary tests. This is the first study to report that medium supplementation with 50 ng/mL of growth and differentiation factor-5 (GDF-5) and 280 μM l-ascorbic acid are essential for tenogenic differentiation of hASCs. Tenogenic medium (TM) was shown to significantly enhance tendon-like matrix production of hASCs compared to other tested media groups. Cell adhesion, proliferation, and tenogenic differentiation of hASCs were supported on braided poly(l/d)lactide (PLA) 96l/4d copolymer filament scaffolds in TM condition compared to foamed poly(l-lactide-co-ε-caprolactone) (PLCL) 70L/30CL scaffolds. A uniform cell layer formed on braided PLA 96/4 scaffolds when hASCs were cultured in TM compared to maintenance medium (MM) condition after 14 days of culture. Furthermore, total collagen content and gene expression of tenogenic marker genes were significantly higher in TM condition after 2 weeks of culture. The elastic modulus of PLA 96/4 scaffold was more similar to the elastic modulus reported for native Achilles tendon. Our study showed that the optimized TM is needed for efficient and rapid in vitro tenogenic extracellular matrix production of hASCs. PLA 96/4 scaffolds together with TM significantly stimulated hASCs, thus demonstrating the potential clinical relevance of this novel and emerging approach to tendon injury treatments in the future.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Research group: Biomaterials and Tissue Engineering Group, BioMediTech, Tampere University Hospital, Univ Helsinki, Helsinki University Central Hospital, University of Helsinki, Cent Hosp, Dept Med, Div Nephrol, University of Twente
Contributors: Vuornos, K., Björninen, M., Talvitie, E., Paakinaho, K., Kellomäki, M., Huhtala, H., Miettinen, S., Seppänen-Kaijansinkko, R., Haimi, S.
Number of pages: 11
Pages: 513-523
Publication date: 1 Mar 2016
Peer-reviewed: Yes

Publication information

Journal: Tissue Engineering Part A
Volume: 22
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ISSN (Print): 1937-3341
Ratings:

Scopus rating (2016): CiteScore 7.7 SJR 1.24 SNIP 0.988
Original language: English
ASJC Scopus subject areas: Bioengineering, Biochemistry, Biomedical Engineering, Biomaterials
DOIs:

10.1089/ten.tea.2015.0276

Bibliographical note

EXT="Vuornos, Kaisa"
Source: Scopus
Source ID: 84961782193
Research output: Contribution to journal › Article › Scientific › peer-review

Bioactive glass ions for in vitro osteogenesis and microvascularization in gellan gum-collagen hydrogels

Lack of bone grafts appeals for bone augmentation solutions. We aimed at osteogenic differentiation of human adipose stem cells (hASCs) and microvascularization in coculture with human umbilical vein endothelial cells (HUVECs) embedded in three-dimensional (3D) gellan gum (GG) and collagen type I (COL) hydrogel mixture. We compared endothelial growth medium-2 (EGM-2) and bioactive glass extract-based endothelial and osteogenic medium (BaG EM-OM) for vascularized bone-like graft development in vitro. Cell viability, cell number, and osteogenic and endothelial gene expression were analyzed. Mineralized hydroxyapatite residues, immunocytochemical staining of endothelial marker CD31 production and late osteogenic marker osteocalcin were imaged. With both media, good cell viability was observed within 3D hydrogel. EGM-2 condition induced significantly higher cell number compared to BaG EM-OM condition at both 7 and 14 days. Interestingly, both media supported osteogenic as well as endothelial marker gene expression. Moreover, formation of reticulated cellular structures was observed in both EGM-2 and BaG EM-OM conditions. However, hydroxyapatite mineralization and strong osteocalcin staining were detected only in BaG EM-OM condition. Importantly, strong production of CD31 and elongated tube-like structures were apparent in EGM-2 culture alone. In conclusion, we demonstrated efficient hASC osteogenic differentiation and microvessel-like network formation in coculture with HUVECs.

General information
Publication status: E-pub ahead of print
MoE publication type: A1 Journal article-refereed
Organisations: BioMediTech, Research group: Biomaterials and Tissue Engineering Group, Tampere University Hospital, Abo Akad Univ, Abo Akademi University, Dept Phys
Contributors: Vuornos, K., Huhtala, H., Kääriäinen, M., Kuismanen, K., Hupa, L., Kellomäki, M., Miettinen, S.
Publication date: 31 Aug 2019
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ISSN (Print): 1552-4973
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Scopus rating (2019): CiteScore 5.3 SJR 0.659 SNIP 0.945
Original language: English
ASJC Scopus subject areas: Biomaterials, Biomedical Engineering
Keywords: adipose stem cell, bioactive glass, collagen type I hydrogel, gellan gum hydrogel, human umbilical vein endothelial cell, osteogenic differentiation, vascularization
DOIs:

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Source: Scopus
Source ID: 85071483860
Research output: Contribution to journal › Article › Scientific › peer-review

3D Scaffolds of Polycaprolactone/Copper-Doped Bioactive Glass: Architecture Engineering with Additive Manufacturing and Cellular Assessments in a Coculture of Bone Marrow Stem Cells and Endothelial Cells
The local delivery of Cu^{2+} from copper-doped bioactive glass (Cu-BaG) was combined with 3D printing of polycaprolactone (PCL) scaffolds for its potent angiogenic effect in bone tissue engineering. PCL and Cu-BaG were, respectively, dissolved and dispersed in acetone to formulate a moderately homogeneous ink. The PCL/Cu-BaG scaffolds were fabricated via direct ink writing into a cold ethanol bath. The architecture of the printed scaffolds, including strut diameter, strut spacing, and porosity, were investigated and characterized. The PCL/Cu-BaG scaffolds showed a Cu-BaG content-dependent mechanical property, as the compressive Young's modulus ranged from 7 to 13 MPa at an apparent porosity of 60%. The ion dissolution behavior in simulated body fluid was evaluated, and the hydroxyapatite-like precipitation on the strut surface was confirmed. Furthermore, the cytocompatibility of the PCL/Cu-BaG scaffolds was assessed in human bone marrow stem cell (hBMSC) culture, and a dose-dependent cytotoxicity of Cu^{2+} was observed. Here, the PCL/BaG scaffold induced the higher expression of late osteogenic genes OSTEOCALCIN and DLX5 in comparison to the PCL scaffold. The doping of Cu^{2+} in BaG elicited higher expression of the early osteogenic marker gene RUNX2a but decreased the expression of late osteogenic marker genes OSTEOCALCIN and DLX5 in comparison to the PCL/BaG scaffold, demonstrating the suppressing effect of Cu^{2+} on osteogenic differentiation of hBMSCs. In a coculture of hBMSCs and human umbilical vein endothelial cells, both the PCL/BaG and PCL/Cu-BaG scaffolds stimulated the formation of a denser tubule network, compared to the PCL scaffold. Meanwhile, only slightly higher gene expression of vWF was observed with the PCL/Cu-BaG scaffold than with the PCL/BaG scaffold, indicating the potent angiogenic effect of the released Cu^{2+}.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: BioMediTech, Research group: Computational Biophysics and Imaging Group, Johan Gadolin Process Chemistry Centre, Abo Akademi University, University of Wollongong, Tampere University Hospital, Tampere University
Contributors: Wang, X., Molino, B. Z., Pitkänen, S., Ojansivu, M., Xu, C., Hannula, M., Hyttinen, J., Miettinen, S., Hupa, L. , Wallace, G.
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Publication date: 18 Jul 2019
Peer-reviewed: Yes

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Journal: ACS Biomaterials Science and Engineering
Volume: 5
Issue number: 9
ISSN (Print): 2373-9878
Ratings:

Scopus rating (2019): CiteScore 6.5 SJR 1.204 SNIP 0.997
Original language: English
ASJC Scopus subject areas: Biomaterials, Biomedical Engineering
Keywords: 3D printing, angiogenesis, coculture of mesenchymal stem cells and endothelial cells, copper-doped bioactive glass, gradient porosity, polycaprolactone, tissue engineering scaffold

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Source: Scopus
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Effects of bioactive glass S53P4 or beta-tricalcium phosphate and bone morphogenetic protein-2 and bone morphogenetic protein-7 on osteogenic differentiation of human adipose stem cells

The effects of bioactive glass S53P4 or beta-tricalcium phosphate; and bone morphogenetic proteins bone morphogenetic protein-2, bone morphogenetic protein-7, or bone morphogenetic protein-2 + 7 on osteogenic differentiation of human adipose stem cells were compared in control medium, osteogenic medium, and bone morphogenetic proteinsupplemented osteogenic medium to assess suitability for bone tissue engineering. Cell amount was evaluated with qDNA measurements; osteogenic differentiation using marker gene expression, alkaline phosphate activity, and angiogenic potential was measured by vascular endothelial growth factor expression. As compared to beta-tricalcium phosphate, cell amount was significantly greater for bioactive glass in control medium after 7 days and in osteogenic medium after 14 days, and alkaline phosphate activity was always significantly greater for bioactive glass in control medium. However, alkaline phosphate activity increased for beta-tricalcium phosphate and decreased for bioactive glass granules in osteogenic medium. For both biomaterials, bone morphogenetic protein supplementation decreased cell amount and osteogenic differentiation of human adipose stem cells, and vascular endothelial growth factor expressions correlated with cell amounts. Effects of culture medium on human adipose stem cells are biomaterial dependent; bioactive glass in control medium enhanced osteogenic differentiation most effectively.

General information

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Organisations: Integrated Technologies for Tissue Engineering Research (ITTE), Tampere University Hospital, Univ of Oulu, University of Helsinki, University of Zurich
Contributors: Waselau, M., Patrikoski, M., Juntunen, M., Kujala, K., Kääriäinen, M., Kuokkanen, H., Sándor, G. K., Vapaavuori, O., Suuronen, R., Mannerström, B., von Rechenberg, B., Miettinen, S.
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Increased survival rate by local release of diclofenac in a murine model of recurrent oral carcinoma

Despite aggressive treatment with radiation and combination chemotherapy following tumor resection, the 5-year survival rate for patients with head and neck cancer is at best only 50%. In this study, we examined the therapeutic potential of localized release of diclofenac from electrospun nanofibers generated from poly(d,l-lactide-co-glycolide) polymer. Diclofenac was chosen since anti-inflammatory agents that inhibit cyclooxygenase have shown great potential in their ability to directly inhibit tumor growth as well as suppress inflammation-mediated tumor growth. A mouse resection model of oral carcinoma was developed by establishing tumor growth in the oral cavity by ultrasound-guided injection of 1 million

SCC-9 cells in the floor of the mouth. Following resection, mice were allocated into four groups with the following treatment: 1) no treatment, 2) implanted scaffolds without diclofenac, 3) implanted scaffolds loaded with diclofenac, and 4) diclofenac given orally. Small animal ultrasound and magnetic resonance imaging were utilized for longitudinal determination of tumor recurrence. At the end of 7 weeks following tumor resection, 33% of mice with diclofenac-loaded scaffolds had a recurrent tumor, in comparison to 90%-100% of the mice in the other three groups. At this time point, mice with diclofenac-releasing scaffolds showed 89% survival rate, while the other groups showed survival rates of 10%-25%. Immunohistochemical staining of recurrent tumors revealed a near 10-fold decrease in the proliferation marker Ki-67 in the tumors derived from mice with diclofenac-releasing scaffolds. In summary, the local application of diclofenac in an orthotopic mouse tumor resection model of oral cancer reduced tumor recurrence with significant improvement in survival over a 7-week study period following tumor resection. Local drug release of anti-inflammatory agents should be investigated as a therapeutic option in the prevention of tumor recurrence in oral squamous carcinoma.

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Contributors: Will, O. M., Purcz, N., Chalaris, A., Heneweer, C., Boretius, S., Purcz, L., Nikkola, L., Ashammakhi, N., Kalthoff, H., Glüer, C. C., Wiltfang, J., Açil, Y., Tiwari, S.
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Light propagation analysis in nervous tissue for wireless optogenetic nanonetworks
In recent years, numerous methods have been sought for developing novel solutions to counter neurodegenerative diseases. An objective that is being investigated by researchers is to develop cortical implants that are able to wirelessly stimulate neurons at the single cell level. This is a major development compared to current solutions that use electrodes, which are only able to target a population of neurons, or optogenetics, which requires optical fiber-leads to be embedded deep into the brain. In this direction, the concept of wireless optogenetic nanonetworks has been recently introduced. In such architecture, miniature devices are implanted in the cortex for neuronal stimulation through optogenetics. One of the aspects that will determine the topology and performance of wireless optogenetic nanonetworks is related to light propagation in genetically-engineered neurons. In this paper, a channel model that captures the peculiarities of light propagation in neurons is developed. First, the light propagation behavior using the modified Beer-Lambert law is analyzed based on the photon transport through the nervous tissue. This includes analyzing the scattering light diffraction and diffusive reflection that results from the absorption of neural cell chromophores, as well as validating the results by means of extensive multiphysics simulations. Then, analysis is conducted on the path loss through cells at different layers of the cortex by taking into account the multi-path phenomenon. Results show that there is a light focusing effect in the soma of neurons that can potentially help the to stimulate the target cells.

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Organisations: Electronics and Communications Engineering, State University of New York
Contributors: Wirdatmadja, S., Johari, P., Balasubramaniam, S., Bae, Y., Stachowiak, M. K., Jornet, J. M.

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Three-dimensional growth matrix for human embryonic stem cell-derived neuronal cells
The future of tissue engineering applications for neuronal cells will require a supportive 3D matrix. This particular matrix should be soft, elastic and supportive for cell growth. In this study, we characterized the suitability of a 3D synthetic hydrogel matrix, PuraMatrix™, as a growth platform for human embryonic stem cell (hESC)-derived neural cells. The viability of the cells grown on top of, inside and under the hydrogel was monitored. The maturation and electrical activity of the neuronal networks inside the hydrogel were further characterized. We showed that cells stayed viable on the top of the PuraMatrix™ surface and growth of the neural cells and neural processes was good. Further, hESC-derived neurons, astrocytes and oligodendrocytes all grew, matured and migrated when cultured inside the hydrogel. Importantly, neuronal cells were able to form electrically active connections that were verified using microelectrode array. Thus, PuraMatrix is a good supportive growth matrix for human neural cells and may serve as a matrix for neuronal scaffolds in neural tissue engineering.

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A 3D Alzheimer's disease culture model and the induction of P21-activated kinase mediated sensing in iPSC derived neurons
The recent progress in stem cell techniques has broadened the horizon for invitro disease modeling. For desired invivo like phenotypes, not only correct cell type specification will be critical, the microenvironmental context will be essential to

achieve relevant responses. We demonstrate how a three dimensional (3D) culture of stem cell derived neurons can induce invivo like responses related to Alzheimer's disease, not recapitulated with conventional 2D cultures. To acquire a neural population of cells we differentiated neurons from neuroepithelial stem cells, derived from induced pluripotent stem cells. p21-activated kinase mediated sensing of Aβ oligomers was only possible in the 3D environment. Further, the 3D phenotype showed clear effects on F-actin associated proteins, connected to the disease processes. We propose that the 3D invitro model has higher resemblance to the AD pathology than conventional 2D cultures and could be used in further studies of the disease.

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Polypyrrole coating on poly-(lactide/glycolide)-β-tricalcium phosphate screws enhances new bone formation in rabbits
Polypyrrole (PPy) has gained interest as an implant material due to its multifunctional properties and its high compatibility with several cell and tissue types. For the first time, the biocompatibility and osteointegration of PPy coating, incorporated with chondroitin sulfate (CS), were studied in vivo by implanting PPy-coated bioabsorbable bone fixation composite screws of poly-(lactide/glycolide) copolymer (PLGA) and β-tricalcium phosphate (TCP) into New Zealand white rabbits. Uncoated bioabsorbable polymer composite screws and commercially available stainless steel cortical screws were used as reference implants. The rabbits were euthanized 12 and 26 weeks after the implantation. The systemic effects were evaluated from food and water consumption, body weight, body temperature, clinical signs, blood samples, internal organ weights, and histological examination. Local effects were studied from bone tissue and surrounding soft tissue histology. New bone formation was evaluated by micro-computed tomography, tetracycline labeling and torsion tests. Torsion tests were performed in order to capture the peak value of the torsion force during the course of the screw's loosening. The coated screws induced significantly more bone formation than the uncoated screws. In addition, none of the implants induced any systemic or local toxicity. The results suggest that PPy is biocompatible with bone tissue and is a potential coating for enhancing osteointegration in orthopedic implants.

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Contributors: Zhao, M. D., Björninen, M., Cao, L., Wang, H. R., Pelto, J., Li, X. Q., Hyttinen, J., Jiang, Y. Q., Kellomäki, M. , Miettinen, S., Sándor, G. K., Seppänen, R., Haimi, S., Dong, J.
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Hybrid nanoparticle design based on cationized gelatin and the polyanions dextran sulfate and chondroitin sulfate for ocular gene therapy

We describe the development of hybrid nanoparticles composed of cationized gelatin and the polyanions CS and DS for gene therapy in the ocular surface. The physicochemical properties of the nanoparticles that impact their bioperformance, such as average size and zeta potential, can be conveniently modulated by changing the ratio of polymers and the crosslinker. These systems associate plasmid DNA and are able to protect it from DNase I degradation. We corroborate that the introduction of CS or DS in the formulation decreases the in vitro toxicity of the nanoparticles to human corneal cells without compromising the transfection efficiency. These nanoparticles are potential candidates for the development of safer and more effective nanomedicines for ocular therapy. New hybrid nanoparticles composed of cationized gelatin and natural polyanions are developed and characterized. The incorporation of chondroitin sulfate or dextran sulfate in cationized gelatin nanoparticles decreases their toxicity while preserving their transfection efficiency in human corneal cells. These nanoparticles are potential candidates for the development of safer and more effective nanomedicines for ocular therapy.

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Contributors: Zorzi, G. K., Párraga, J. E., Seijo, B., Sánchez, A.
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