Pyrolysed cellulose nanofibrils and dandelion pappus in supercapacitor application

Dandelion pappus and wood based nanocellulose fibrils were combined to form films that were subsequently pyrolyzed under low-pressure conditions in a carbon monoxide (CO) rich atmosphere to make supercapacitor electrode material. The electrodes were prepared from these materials and pyrolyzed under low-pressure conditions in a carbon monoxide-rich atmosphere. The electrode materials and assembled supercapacitors were electrically and structurally characterized. The assembled six supercapacitors showed specific capacitances per electrode ranging from 1 to 6 F/g and surface resistance of pyrolyzed electrodes ranging from 30 to 170 Ω. Finally, equivalent series resistance and leakage current measurements were conducted for three samples, resulting values from 125 to 500 Ω and from 0.5 to 5.5 µA, respectively.

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Organisations: Faculty of Biomedical Sciences and Engineering, Research area: Microsystems, Electronics and Communications Engineering, Materials Science, Research group: Plastics and Elastomer Technology, Research group: Plastics and Elastomer Technology, Research area: Measurement Technology and Process Control, Research group: Sensor Technology and Biomeasurements (STB), BioMediTech, BioMediTech Institute and Faculty of Biomedical Sciences and Engineering
Authors: Virtanen, J., Pammo, A., Keskinen, J., Sarlin, E., Tuukkanen, S.
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Scopus rating (2014): SJR 1.071 SNIP 1.334 CiteScore 3.58
Scopus rating (2013): SJR 1.127 SNIP 1.48 CiteScore 3.83
Scopus rating (2012): SJR 1.179 SNIP 1.71 CiteScore 3.74
Scopus rating (2011): SJR 1.354 SNIP 1.795 CiteScore 3.99
Scopus rating (2010): SJR 0.873 SNIP 1.384
Scopus rating (2009): SJR 1.038 SNIP 1.219
Scopus rating (2008): SJR 0.926 SNIP 1.123
Scopus rating (2007): SJR 0.754 SNIP 1.034
Scopus rating (2006): SJR 0.699 SNIP 1.15
Scopus rating (2005): SJR 1.112 SNIP 1.318
Scopus rating (2004): SJR 0.855 SNIP 1.072
Scopus rating (2003): SJR 0.81 SNIP 1.02
Scopus rating (2002): SJR 0.649 SNIP 0.689
Scopus rating (2001): SJR 0.602 SNIP 0.785
Scopus rating (2000): SJR 0.583 SNIP 0.773
Scopus rating (1999): SJR 0.67 SNIP 1.14
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INT="Pammo, Arno"
Research output: Scientific - peer-review › Article

Engineering and Characterization of Bacterial Nanocellulose Films as Low Cost and Flexible Sensor Material

Some bacterial strains such as Komagataeibacter xylinus are able to produce cellulose as an extracellular matrix. In comparison to wood-based cellulose, bacterial cellulose (BC) holds interesting properties such as biodegradability, high purity, water-holding capacity, and superior mechanical and structural properties. Aiming toward improvement in BC production titer and tailored alterations to the BC film, we engineered K. xylinus to overexpress partial and complete bacterial cellulose synthase operon that encodes activities for BC production. The changes in cell growth, end metabolite, and BC production titers from the engineered strains were compared with the wild-type K. xylinus. Although there were no
significant differences between the growth of wild-type and engineered strains, the engineered K. xylinus strains demonstrated faster BC production, generating 2–4-fold higher production titer (the highest observed titer was obtained with K. xylinus-bcsABCD strain producing 4.3 ± 0.46 g/L BC in 4 days). The mechanical and structural characteristics of cellulose produced from the wild-type and engineered K. xylinus strains were analyzed with a stylus profilometer, in-house built tensile strength measurement system, a scanning electron microscope, and an X-ray diffractometer. Results from the profilometer indicated that the engineered K. xylinus strains produced thicker BC films (wild type, 5.1 μm, and engineered K. xylinus strains, 6.2–10.2 μm). Scanning electron microscope revealed no principal differences in the structure of the different type BC films. The crystallinity index of all films was high (from 88.6 to 97.5%). All BC films showed significant piezoelectric response (5.0–20 pC/N), indicating BC as a promising sensor material.

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Authors: Mangayil, R., Rajala, S., Pammo, A., Sarlin, E., Luo, J., Santala, V., Karp, M., Tuukkanen, S.
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Peer-reviewed: Yes

Collagen-immobilized polyimide membranes for retinal pigment epithelial cell adherence and proliferation
Degenerative retinal diseases are a leading cause of visual loss and irreversible blindness, particularly in the developed world. Retinal pigment cell (RPE) transplantation is nowadays considered the most promising therapeutic approach for certain retinal diseases, and the presence of a supportive scaffold has been considered essential to ensure the success of the implant. In this work, collagen IV was covalently immobilized to the surface of polyimide membranes, with the purpose of developing scaffold materials for RPE cell culture. The covalent modification method involved four steps: argon-plasma treatment, acrylic acid graft polymerization, surface activation, and finally immobilization of collagen type IV. Collagen-modified membranes did not become more rough but became significantly more hydrophilic than the unmodified and dip-coated controls. ARPE-19 cell morphology and attachment were studied by immunofluorescence staining and confocal microscopy. Covalently modified surfaces showed cell attachment and cell properties comparable to the uncoated and dip-coated controls. This work demonstrated the potential of collagen IV-immobilized polyimide membranes as substrates for the growth of ARPE-19 cells.

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Organisations: Faculty of Biomedical Sciences and Engineering, Research group: Biomaterials and Tissue Engineering Group, BioMediTech, University of Tampere, BioMediTech
Authors: Teymouri, S., Calejo, M. T., Hiltunen, M., Sorkio, A. E., Juuti-Uusitalo, K., Skottman, H., Kellomäki, M.
Langmuir-Schaefer film deposition onto honeycomb porous films for retinal tissue engineering

Age-related macular degeneration (AMD) is the leading cause of vision loss in senior citizens in the developed world. The disease is characterised by the degeneration of a specific cell layer at the back of the eye – the retinal pigment epithelium (RPE), which is essential in retinal function. The most promising therapeutic option to restore the lost vision is considered to be RPE cell transplantation. This work focuses on the development of biodegradable biomaterials with similar properties to the native Bruch’s membrane as carriers for RPE cells. In particular, the breath figure (BF) method was used to create semi-permeable microporous films, which were thereafter used as the substrate for the consecutive Langmuir-Schaefer (LS) deposition of highly organised layers of collagen type I and collagen type IV. The newly developed biomaterials were further characterised in terms of surface porosity, roughness, hydrophilicity, collagen distribution, diffusion properties and hydrolytic stability. Human embryonic stem cell-derived RPE cells (hESC-RPE) cultured on the biomaterials showed good adhesion, spreading and morphology, as well as the expression of specific protein markers. Cell function was additionally confirmed by the assessment of the phagocytic capacity of hESC-RPE. Throughout the study, microporous films consistently showed better results as cell culture materials for hESC-RPE than dip-coated controls. This work demonstrates the potential of the BF-LS combined technologies to create biomimetic prosthetic Bruch’s membranes for hESC-RPE transplantation.
Improved antifouling properties and selective biofunctionalization of stainless steel by employing heterobifunctional silane-polyethylene glycol overlayers and avidin-biotin technology

A straightforward solution-based method to modify the biofunctionality of stainless steel (SS) using heterobifunctional silane-polyethylene glycol (silane-PEG) overlayers is reported. Reduced nonspecific biofouling of both proteins and bacteria onto SS and further selective biofunctionalization of the modified surface were achieved. According to photoelectron spectroscopy analyses, the silane-PEGs formed less than 10 Å thick overlayers with close to 90% surface coverage and reproducible chemical compositions. Consequently, the surfaces also became more hydrophilic, and the observed non-specific biofouling of proteins was reduced by approximately 70%. In addition, the attachment of E. coli was reduced by more than 65%. Moreover, the potential of the overlayer to be further modified was demonstrated by successfully coupling biotinylated alkaline phosphatase (bAP) to a silane-PEG-biotin overlayer via avidin-biotin bridges. The activity of the immobilized enzyme was shown to be well preserved without compromising the achieved antifouling properties. Overall, the simple solution-based approach enables the tailoring of SS to enhance its activity for biomedical and biotechnological applications.

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Scopus rating (2013): SJR 1.886 SNIP 1.51 CiteScore 4.06
Scopus rating (2012): SJR 1.458 SNIP 0.896 CiteScore 2.44
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Research output: Scientific - peer-review › Article

Articular cartilage repair with recombinant human type II collagen/polylactide scaffold in a preliminary porcine study

The purpose of this study was to investigate the potential of a novel recombinant human type II collagen/polylactide scaffold (rhCo-PLA) in the repair of full-thickness cartilage lesions with autologous chondrocyte implantation technique (ACI). The forming repair tissue was compared to spontaneous healing (spontaneous) and repair with a commercial porcine type I/III collagen membrane (pCo). Domestic pigs (4-month-old, n = 20) were randomized into three study groups and a circular full-thickness chondral lesion with a diameter of 8 mm was created in the right medial femoral condyle. After 3 weeks, the chondral lesions were repaired with either rhCo-PLA or pCo together with autologous chondrocytes, or the lesion was only debrided and left untreated for spontaneous repair. The repair tissue was evaluated 4 months after the second operation. Hyaline cartilage formed most frequently in the rhCo-PLA treatment group. Biomechanically, there was a trend that both treatment groups resulted in better repair tissue than spontaneous healing. Adverse subchondral bone reactions developed less frequently in the spontaneous group (40%) and the rhCo-PLA treated group (50%) than in the pCo control group (100%). However, no statistically significant differences were found between the groups. The novel rhCo-PLA biomaterial showed promising results in this proof-of-concept study, but further studies will be needed in order to determine its effectiveness in articular cartilage repair.

General information
Functionalizing Surface Electrical Potential of Hydroxyapatite Coatings

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Organisations: Department of Materials Science, Research group: Surface Engineering, Riga Technical University, University of Adelaide
Authors: Pluduma, L., Freimanis, E., Gross, K., Koivuluoto, H., Algate, K., Haynes, D., Vuoristo, P.
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Machine-coated starch-based dispersion coatings prevent mineral oil migration from paperboard

Mineral oil migration through paperboard presents a safety risk in modern food packaging. This study aimed to enhance the safety of fiber-based packaging by utilizing a bio-based composite barrier layer to protect against mineral oil. Starch-clay composite coatings on paperboard were created via dispersion coating. Thermal analysis of the coating components and field emission scanning electron microscopy imaging were performed to ascertain the physicochemical properties and morphology of the coatings. Coating functionality was evaluated using contact angles and transmission rate (water and oxygen) measurements. The packaging safety focus was implemented by measuring the gas phase migration of heptane and analyzing the migration of liquid mineral oil through the coated paperboards with FTIR. The functional properties of the coated paperboards were maintained or improved. The studied coatings were effective barriers against the migration of mineral oil and could hence improve the barrier properties and safety of fiber-based primary food packaging.

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
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.
Processing and characterization of phosphate glasses containing CaAl2O4:Eu2+,Nd3+ and SrAl2O4:Eu2+,Dy3+ microparticles

In this paper, phosphate based glasses with persistent luminescence properties were processed using standard melting process in air by adding SrAl2O4:Eu2+,Dy3+ or CaAl2O4:Eu2+,Nd3+ in the glass batch before melting. All produced glasses were characterized using SEM/EDXA, Raman spectroscopy and photoluminescence. We discuss the effect of melting conditions (temperature and duration of the melting) on the persistent luminescence properties of the microparticles containing glasses. It is demonstrated that the melting in air allows for the preparation of glasses with persistent luminescence if the melting conditions are carefully controlled.
Erbium-doped borosilicate glasses containing various amounts of P2O5 and Al2O3: Influence of the silica content on the structure and thermal, physical, optical and luminescence properties
Strontium- and calcium-containing, titanium-stabilised phosphate-based glasses with prolonged degradation for orthopaedic tissue engineering

General information
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Ministry of Education 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
Authors: Al Qaysi, M., Walters, N. J., Foroutan, F., Owens, G. J., Kim, H. W., Shah, R., Knowles, J. C.
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Scopus rating (2014): SJR 0.659 SNIP 1.004 CiteScore 2.53
Scopus rating (2013): SJR 0.72 SNIP 1.026 CiteScore 2.35
Scopus rating (2012): SJR 0.792 SNIP 0.958 CiteScore 2.08
Scopus rating (2011): SJR 0.804 SNIP 1.089 CiteScore 2.16
Scopus rating (2010): SJR 0.921 SNIP 1.068
Scopus rating (2009): SJR 0.67 SNIP 1.082
Scopus rating (2008): SJR 0.603 SNIP 0.758
Scopus rating (2007): SJR 0.682 SNIP 0.801
Scopus rating (2006): SJR 0.585 SNIP 0.823
Scopus rating (2005): SJR 0.327 SNIP 0.591
Scopus rating (2004): SJR 0.354 SNIP 0.446
Scopus rating (2003): SJR 0.436 SNIP 0.514
Scopus rating (2002): SJR 0.597 SNIP 0.875
Scopus rating (2001): SJR 0.553 SNIP 0.896
Scopus rating (2000): SJR 0.417 SNIP 0.583
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Research output: Scientific - peer-review › Article

Er3+-Al2O3 nanoparticles doping of borosilicate glass
Novel borosilicate glasses were developed by adding in the glass batch Er3+-Al2O3 nanoparticles synthetized by using a soft chemical method. A similar nanoparticle doping with modified chemical vapour deposition (MCVD) process was
developed to increase the efficiency of the amplifying silica fibre in comparison to using MCVD and solution doping. It was shown that with the melt quench technique, a Er3+-Al2O3 nanoparticle doping neither leads to an increase in the Er3+ luminescence properties nor allows one to control the rare-earth chemical environment in a borosilicate glass. The site of Er3+ in the Er3+-Al2O3 nanoparticle containing glass seems to be similar as in glasses with the same composition prepared using standard raw materials. We suspect the Er3+ ions to diffuse from the nanoparticles into the glass matrix. There was no clear evidence of the presence of Al2O3 nanoparticles in the glasses after melting.

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Organisations: Department of Electronics and Communications Engineering, Research group: Biomaterials and Tissue Engineering Group, Frontier Photonics, Integrated Technologies for Tissue Engineering Research (ITTE), Light Corporation, CNRS, Université de Bordeaux, ICMCB, Johan Gadolin Process Chemistry Centre, Abo Akademi University
Authors: Massera, J., Petit, L., Koponen, J., Glorieux, B., Hupa, L., Hupa, M.
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Scopus rating (2015): SJR 0.358 SNIP 0.703 CiteScore 1.11
Scopus rating (2014): SJR 0.437 SNIP 0.982 CiteScore 1.31
Scopus rating (2013): SJR 0.402 SNIP 0.866 CiteScore 1.09
Scopus rating (2012): SJR 0.317 SNIP 0.811 CiteScore 1.04
Scopus rating (2011): SJR 0.448 SNIP 0.955 CiteScore 1.14
Scopus rating (2010): SJR 0.493 SNIP 0.784
Scopus rating (2009): SJR 0.426 SNIP 0.681
Scopus rating (2008): SJR 0.415 SNIP 0.812
Scopus rating (2007): SJR 0.439 SNIP 0.7
Scopus rating (2006): SJR 0.318 SNIP 0.715
Scopus rating (2005): SJR 0.409 SNIP 1.021
Scopus rating (2004): SJR 0.378 SNIP 0.708
Scopus rating (2003): SJR 0.345 SNIP 0.705
Scopus rating (2002): SJR 0.341 SNIP 0.576
Scopus rating (2001): SJR 0.302 SNIP 0.653
Scopus rating (2000): SJR 0.278 SNIP 0.367
Scopus rating (1999): SJR 0.191 SNIP 0.529
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**Improved dimensional stability with bioactive glass fibre skeleton in poly(lactide-co-glycolide) porous scaffolds for tissue engineering**

Abstract Bone tissue engineering requires highly porous three-dimensional (3D) scaffolds with preferable osteoconductive properties, controlled degradation, and good dimensional stability. In this study, highly porous 3D poly(l-lactide-co-glycolide) (PLGA) - bioactive glass (BG) composites (PLGA/BG) were manufactured by combining highly porous 3D fibrous BG mesh skeleton with porous PLGA in a freeze-drying process. The 3D structure of the scaffolds was investigated as well as in vitro hydrolytic degradation for 10 weeks. The effect of BG on the dimensional stability, scaffold composition, pore structure, and degradation behaviour of the scaffolds was evaluated. The composites showed superior pore structure as the BG fibres inhibited shrinkage of the scaffolds. The BG was also shown to buffer the acidic degradation products of PLGA. These results demonstrate the potential of these PLGA/BG composites for bone tissue
engineering, but the ability of this kind of PLGA/BG composites to promote bone regeneration will be studied in forthcoming in vivo studies.

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.

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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

Authors: Ojansivu, M., Vanhatupa, S., Björkvik, L., Häkkänen, H., Kellomäki, M., Autio, R., Ihalainen, J. A., Hupa, L., Miettinen, S.

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Scopus rating (2013): SJR 1.963 SNIP 2.269 CiteScore 6.41

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Scopus rating (2011): SJR 1.808 SNIP 1.91 CiteScore 5.15

Scopus rating (2010): SJR 1.794 SNIP 1.964

Scopus rating (2009): SJR 1.399 SNIP 1.662

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Scopus rating (2007): SJR 1.199 SNIP 1.493

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ASJC Scopus subject areas: Biomaterials, Biomedical Engineering, Biotechnology, Biochemistry, Molecular Biology

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**Bibliographical note**

EXT="Autio, Reija"

Source: Scopus

Source-ID: 84929951673

Research output: Scientific - peer-review  Article

**Application of Biopolymer Doped Polypyrroles in Biomedical Implants and Electrical Stimulation Devices**

Organic conductive polymers are emerging new materials for biomedical engineering. They offer surface properties which are attractive for many biomedical applications, such as surface coatings on metallic or biodegradable polymeric implants, tissue engineering scaffolds, implantable electronic tissue stimulation devices and microelectromechanical systems for the manipulation of single living cells in vitro, for example. Owing to the proven compatibility with tissues and cells, conductive polypyrrole (PPy) has been intensively investigated for bone and neural stimulation applications. A salient feature of PPy is its easy modification with bioactive molecules and macromolecules, such as the extracellular matrix (ECM) components of animal tissues. This work assessed the ECM components hyaluronic acid (HA) and chondroitin sulfate (CS) as dopants, which we incorporated into the PPy during the syntheses by electrochemical and oxidative chemical polymerization.

Biopolymer doped PPys have been earlier reported to be good substrates for cell cultures. Furthermore, preceding implantation studies have shown promising results. However, considering clinical application and registration of PPy as a biomaterial in commercial cell culturing or tissue engineering products, there are still many practical aspects requiring more attention, such as the establishment of feasible synthetic routes, sterilizability, preservation of the electronic properties during storage and during the incubation in physiological conditions, possible biodegradation mechanisms, stability and biological elimination of the degradation products in vivo, for example. Mass spectroscopy of the hydrolysis products of polylactide (PLA) fibers coated with layer of PPy, suggested that the PPy was biostable in water at neutral pH. Electrical conductivity measurements and Raman spectroscopy showed that the PPy chain was prone to de-doping, and...
hence the lost its conductivity under biological conditions, but these effects were partly reversible by acid doping and positively biased electrochemical potential. The electrochemical redox activity and electromechanical actuation property of the biopolymer doped PPy was thoroughly studied. It was shown that the biopolymer doped PPy had significant and reversible redox activity, which could be potentially utilized in microelectromechanical stimulation of cells and implantable microscopic actuators.

Practical and reproducible polymerization protocols were developed during this work. We took novel approaches and suggested a relatively simple “one-pot” chemical polymerization scheme, avoiding the complications of biological functionalization using potentially toxic click-chemistry. The developed methods were successfully applied in the deposition of electrically conductive, biopolymer doped PPy coatings on polylactide (PLA) nonwoven tissue engineering scaffolds and commercial poly(lactide-co-glycolide)-β-tricalcium phosphate (PLGA-β-TCP) bone fixation screws.

The physical properties and cell response of HA and CS doped PPy (PPyHA and PPyCS) electrode coatings were investigated by atomic force microscopy (AFM) and electrochemical methods. Drastically different behaviour of adipose stem cells (hASC) was found on the different electrode coatings, highlighting the sensitivity of the hASCs on the nanoscopic and microscopic surface properties of the PPy substrate, such as surface roughness, elasticity and surface potential distribution, factors which could be engineered during the synthesis and affected by external stimuli during incubation in cell culture medium.

In conclusion, the results of this thesis supported the use of PPy coatings in bone tissue engineering. The electropolymerized films and also the chemically polymerized PPyHA and PPyCS coatings on bioabsorbable polymer were highly compatible with hASCs, supported cell adhesion and could be utilized in delivering direct electrical stimulation in vitro. There is also further potential in designing permanently implantable scaffolds and microstimulation devices, but still further insight into the biodegradation mechanism and biological elimination of PPy in vivo is needed.

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Authors: Pelto, J.
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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.

Optimising polylactide melt spinning using real-time monitoring
Polylactide (PLA) is a synthetic biodegradable polyester and it is usually processed into fibres by two-step melt spinning, which comprises of (i) melting the raw material and pushing the melt through small orifices and (ii) stretching and heat treating the fibre to increase its mechanical properties. However, processing biodegradable polymers is challenging because the polymer degrades thermally which narrows the choice of the processing parameters. Real-time monitoring allows monitoring of the key properties of the material during the production of the fibre.

There were two objectives for this work: (i) upscaling the production of 4-filament PLA fibre with an updated set-up with real-time monitoring and (ii) studying the hydrolytic degradation of PLA fibres manufactured with the conventional set-up. The updated set-up comprised of high-speed spinning plants and a twin-screw extruder equipped with a slit die for later real-time monitoring of parameters related to thermal degradation of the polymer. The processing conditions of polylactide melt spinning were optimised by two sets of trials; initial trials with a packaging grade PLA and a second set of trials with GMP grade poly(L/D)lactide with an L/D ratio of 96/4.

The obtained fibres were characterised by tensile testing and the temperature-induced chain scission was evaluated by inherent viscosity (i.v.) measurements. Goal values were established to enable
the post-processing of the fibres. Mechanically adequate fibre was produced in the initial trials regarding the material used and the filament diameters fulfilled the requirements. The packaging grade PLA did not degrade during extrusion but the i.v. of the GMP grade PLA was decreased by one third. The filament diameter and the strain values were at an acceptable level in half of the spools produced in the GMP grade trials. In the initial trials there was a problem with the fluctuation of the filament diameters but it was largely solved by a change of the feeding equipment in the GMP grade trials. There is a need for further optimisation of the mechanical properties. This should be done by increasing the draw ratio. However, the ultimate tensile strength of the fibre was close to the required value.

In addition a 48-week hydrolysis study was conducted on the fibre produced with the conventional set-up. The molecular, rheological, thermal and mechanical properties of gamma irradiated and non-irradiated fibres were measured. The molecular weights and inherent viscosities of both fibres decreased steadily, but the irradiated fibre degraded more prominently. The mechanical performance of the non-irradiated fibre showed no changes but the irradiated fibre could no longer be tested after 28 weeks. In conclusion, the results of the hydrolytic degradation studies were mainly in line with earlier studies. These results can be used as a reference for the future hydrolytic degradation studies for the fibre manufactured with the upgraded set-up.

Chitosan membranes in a rat model of full-thickness cutaneous wounds: Healing and IL-4 levels

Objective: The aim of this study was to examine the effect of chitosan membrane on wound healing. Method: The effect of chitosan membranes was evaluated in an experimental rat model. On day 0, circular full-thickness skin sections were excised from the scalps of rats. The wounds were then measured and the surrounding area tattooed. Rats were sacrificed either immediately after excision, or randomised into control and chitosan groups and followed up on day 3, 7, 14 or 21. Control group wounds were covered with Aquacel (wound dressing). Chitosan group wounds were covered with chitosan membranes and the wound dressing. Wounds and the distances between the tattooed marks were measured on follow-up, the wound sites were harvested and histologically examined, and serum interleukin (IL-4) levels were analysed.

Results: A total of 54 rats were examined and all time points included 6 control and 6 chitosan treated animals, except for day 0 which consisted of control animals only. On day 3, wounds in the chitosan group were significantly (p<0.05) smaller (60 ± 6% versus 78 ± 19% of the original wound area) than in the control group. Chitosan membranes were found to degrade at the wound sites between days 7 and 14. Leukocyte counts were lower in the chitosan group than in the control group on day seven (p<0.05). IL-4 levels were significantly higher on day 7 (p<0.001) and 14 (p<0.001) in the chitosan group. Conclusion: According to our results chitosan membrane may promote early wound healing, reduce inflammation and affect the IL-4 pathway, however, the membrane degrades at the wound site after day 7.
Dissolution behavior of the bioactive glass S53P4 when sodium is replaced by potassium, and calcium with magnesium or strontium

The initial dissolution behavior of glasses based on bioactive glass S53P4 was studied with a dynamic measurement setup in a Tris-buffered solution. The glass composition was modified systematically on a molar basis by replacing sodium oxide with potassium oxide (0-100% K) and calcium oxide with magnesium (0-18% Mg) or strontium oxide (0-100% Sr). The concentrations of the ions dissolving from the glasses were measured continuously on-line in the fluid flow for 15 to 25 min using an inductively coupled plasma emission optical spectrometer. This method enabled attainment of detailed information on the initial dissolution mechanisms without the, for bioactive glasses typical, interference of apatite layer formation. The results showed that initial dissolutions of sodium and potassium were markedly higher from the mixed alkali oxide glasses than from the compositions containing only one alkali oxide. Introducing MgO in S53P4 caused a minor decrease in the dissolution rates of all ions. The glass containing 3 mol% of MgO showed the best chemical durability. In contrast, replacing CaO gradually with SrO increased the dissolution rates of all ions. The glasses with the highest replacement of CaO with SrO showed rapid release of both Sr and Na ions. The results corroborate the overall knowledge of glass durability and can be utilized to design bioactive glasses with controlled ion release rate for tissue engineering applications.

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Authors: Hupa, L., Fagerlund, S., Massera, J., Björkvik, L.
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Bioabsorbable fabrics for musculoskeletal scaffolds

This chapter discusses how woven, braided, and knitted scaffolds have been used in bone, cartilage, tendon, and ligament tissue engineering (TE). First, we describe the different steps for manufacturing filaments, yarns, and bioabsorbable textiles. Then we discuss issues related to the characterization and modelling of fabrics and scaffolds. In separate sections, we also consider four different applications of experimental TE using textile scaffolds, and we list currently available commercial products.

General information

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Authors: Kellomäki, M., Laine, K., Ellä, V., Annala, T.
Number of pages: 24
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Source: Scopus
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Research output: Scientific - peer-review › Chapter
The internet of Bio-Nano things
The Internet of Things (IoT) has become an important research topic in the last decade, where things refer to interconnected machines and objects with embedded computing capabilities employed to extend the Internet to many application domains. While research and development continue for general IoT devices, there are many application domains where very tiny, concealable, and non-intrusive Things are needed. The properties of recently studied nanomaterials, such as graphene, have inspired the concept of Internet of NanoThings (IoNT), based on the interconnection of nanoscale devices. Despite being an enabler for many applications, the artificial nature of IoNT devices can be detrimental where the deployment of NanoThings could result in unwanted effects on health or pollution. The novel paradigm of the Internet of Bio-Nano Things (IoBNT) is introduced in this paper by stemming from synthetic biology and nanotechnology tools that allow the engineering of biological embedded computing devices. Based on biological cells, and their functionalities in the biochemical domain, Bio-NanoThings promise to enable applications such as intra-body sensing and actuation networks, and environmental control of toxic agents and pollution. The IoBNT stands as a paradigm-shifting concept for communication and network engineering, where novel challenges are faced to develop efficient and safe techniques for the exchange of information, interaction, and networking within the biochemical domain, while enabling an interface to the electrical domain of the Internet.

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Organisations: Department of Electronics and Communications Engineering, Research group: Emerging Technologies for Nano-Bio-Info-Cogno, Wireless Communications and Positioning (WICO), University of Nebraska, Georgia Institute of Technology
Authors: Akyildiz, I. F., Pierobon, M., Balasubramaniam, S., Koucheryavy, Y.
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Scopus rating (2015): SJR 2.449 SNIP 6.066 CiteScore 8.15
Scopus rating (2014): SJR 2.678 SNIP 4.808 CiteScore 6.54
Scopus rating (2013): SJR 2.584 SNIP 5.643 CiteScore 6.08
Scopus rating (2012): SJR 2.867 SNIP 5.416 CiteScore 5.73
Scopus rating (2011): SJR 2.242 SNIP 5.121 CiteScore 4.97
Scopus rating (2010): SJR 2.29 SNIP 3.65
Scopus rating (2009): SJR 1.817 SNIP 3.976
Scopus rating (2008): SJR 1.893 SNIP 3.918
Scopus rating (2007): SJR 2.331 SNIP 4.411
Scopus rating (2006): SJR 2.085 SNIP 4.483
Scopus rating (2005): SJR 2.788 SNIP 5.649
Scopus rating (2001): SJR 3.614 SNIP 4.662
Scopus rating (2000): SJR 2.945 SNIP 3.261
Scopus rating (1999): SJR 1.974 SNIP 2.863
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ASJC Scopus subject areas: Electrical and Electronic Engineering, Computer Science Applications, Computer Networks and Communications
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Research output: Scientific - peer-review › Article
Binary TiO2/SiO2 nanoparticle coating for controlling the wetting properties of paperboard

We introduce a flame based aerosol method to fabricate thin films consisting of binary TiO2/SiO2 nanoparticles deposited directly from the flame onto the paperboard. Nanocoatings were prepared with Liquid Flame Spray (LFS) in a roll-to-roll process with the line speed of 50 m/min. Surface wetting behavior of nanocoated paperboard was studied for different Ti/Si ratios in the precursor, affecting TiO2/ SiO2 ratio in the coating. Wettability could be adjusted to practically any water contact angle between 10 and 1600 by setting the Ti/Si ratio in the liquid precursor. Structure of the two component nanocoating was analysed with FE-SEM, TEM, EDS, XPS and XRD. The porous thin film coating was concluded to consist of ca. 10 nm sized mixed oxide nanoparticles with segregated TiO2 and SiO2 phases. Accumulation of carbonaceous compounds on the surface was seen to be almost linearly dependent on the Ti/Si ratio, indicating of each species being exposed in corresponding amount. However, wetting of the surface was observed to follow merely an S-shaped curve, caused by the roughness of the nanocoated surface. Reasons for the observed superhydrophobicity and superhydrophilicity of these binary nanocoatings on paperboard are discussed. (C) 2014 Elsevier B.V. All rights reserved.

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Organisations: Department of Physics, Research area: Aerosol Physics, Research group: Aerosol Synthesis, Department of Materials Science, Research group: Paper Converting and Packaging, Engineering materials science and solutions (EMASS), Abo Akad Univ, Abo Akademi University, Lab Paper Coating & Converting, Univ Helsinki, University of Helsinki, Dept Chem, Inorgan Chem Lab
Authors: Haapanen, J., Aromaa, M., Teisala, H., Tuominen, M., Stepien, M., Saarinen, J. J., Heikkila, M., Toivakka, M., Kuusipalo, J., Mäkelä, J.
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Peer-reviewed: Yes

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Scopus rating (2014): SJR 0.856 SNIP 1.298 CiteScore 2.59
Scopus rating (2013): SJR 0.818 SNIP 1.265 CiteScore 2.38
Scopus rating (2012): SJR 0.916 SNIP 1.445 CiteScore 2.41
Scopus rating (2011): SJR 0.95 SNIP 1.466 CiteScore 2.56
Scopus rating (2010): SJR 1.045 SNIP 1.273
Scopus rating (2009): SJR 0.986 SNIP 1.297
Scopus rating (2008): SJR 0.936 SNIP 1.311
Scopus rating (2007): SJR 1.007 SNIP 1.339
Scopus rating (2006): SJR 0.948 SNIP 1.334
Scopus rating (2005): SJR 0.782 SNIP 1.182
Scopus rating (2004): SJR 0.665 SNIP 0.936
Scopus rating (2003): SJR 0.64 SNIP 1.15
Scopus rating (2002): SJR 0.603 SNIP 0.8
Scopus rating (2001): SJR 0.497 SNIP 0.834
Scopus rating (2000): SJR 0.553 SNIP 0.77
Scopus rating (1999): SJR 0.373 SNIP 0.657
Original language: English
Keywords: Coatings, Composite materials, Nanostructures, Surfaces, Thin films, LIQUID FLAME SPRAY, SUPERHYDROPHOBIC SURFACES, WETTABILITY CONVERSION, AEROSOL SYNTHESIS, TITANIA, PYROLYSIS, SiO2/TiO2, DEPOSITS, POWDERS, OXIDES
DOIs:
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Bibliographical note
Available online 19 October; vol 149-150, 2015, s. 230-237<br/>Contribution: organisation=mol,FACT1=0.5<br/>Contribution: organisation=fys,FACT2=0.5<br/>Portfolio EDEND: 2015-01-13
Biodegradable passive resonance sensor: Fabrication and initial testing

Biodegradable resonance circuits were studied. The circuits have a novel two-layer resonator structure without galvanic through hole vias. A patterned magnesium layers were evaporated on biodegradable PLA sheets by using a 3D printed mask. The circuits were assembled by heat sealing two magnesium patterned sheets together to encapsulate the circuit structure. An inductive link is used to wirelessly detect the resonance frequency of the circuit. The circuits were tested when immersed in de-ionised water and saline. According to the tests, the designed resonator structure can be measured in aqueous environment. The resonance of the tested circuit was observable at least for 51 hours. The concept still needs more development to extend degradation time and to increase the stability during immersion.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Authors: Salpavaara, T., Ellä, V., Kellomäki, M., Lekkala, J.
Number of pages: 5
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ASJC Scopus subject areas: Biomedical Engineering, Electrical and Electronic Engineering
Keywords: Biodegradable, Passive resonance sensor
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http://www.scopus.com/inward/record.url?scp=84936806627&partnerID=8YFLogxK (Link to publication in Scopus)

Miksi villalanka aiheuttaa allergiaa?

General information
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Ministry of Education publication type: E1 Popularised article, newspaper article
Organisations: Department of Materials Science, Research group: Fibre Materials
Authors: Rissanen, M.
Publication date: 2015
Peer-reviewed: Unknown

Publication information
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Issue number: 1
Original language: Finnish
Research output: General public » Letter

Muraglitazar-Eluting Bioabsorbable Vascular Stent Inhibits Neointimal Hyperplasia in Porcine Iliac Arteries
Purpose To evaluate the biocompatibility of a new muraglitazar-eluting polylactide copolymer stent and investigate its ability to prevent the formation of intimal hyperplasia.

Materials and Methods Ten self-expandable muraglitazar-eluting poly-96l/4d-lactic acid (PLA96) stents and 10 self-expandable control PLA96 stents were implanted into porcine common iliac arteries. After 28 days follow-up, all stent-
implanted iliac arteries were harvested and prepared for quantitative histomorphometric analysis.

Results Angiographic analysis revealed that one control PLA96 stent had occluded and one had migrated. Histomorphometric analysis demonstrated that, with the control PLA96 stent, the luminal diameter and area were decreased versus the muraglitazar-eluting PLA96 stents (means ± standard error of the mean, 3.58 mm ± 0.34 vs 4.16 mm ± 0.14 and 9.83 mm² ± 2.41 vs 13.75 mm² ± 0.93, respectively). The control PLA96 stent induced more intimal hyperplasia than the bioactive muraglitazar-eluting PLA96 stent (557 μm ± 122 vs 361 μm ± 32). Vascular injury scores demonstrated only mild vascular trauma for both stents (muraglitazar-eluting, 0.68 ± 0.07; control, 0.75 ± 0.08). Inflammation scores also showed mild inflammation for both stents (muraglitazar-eluting, 1.05 ± 0.17; control, 1.23 ± 0.19).

Conclusions This new muraglitazar-eluting PLA96 stent was shown to be biocompatible with a tendency for better patency and less intimal hyperplasia compared with the control PLA96 stents.

General information
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Organisations: Department of Electronics and Communications Engineering, BioMediTech, Integrated Technologies for Tissue Engineering Research (ITTE), Prostate cancer research center (PCRC)
Authors: Uurto, I., Hämäläinen, M., Suominen, V., Laurila, M., Kotsar, A., Isotalo, T., Tammela, T. L., Kellomäki, M., Salenius, J.
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Scopus rating (2015): SJR 1.25 SNIP 1.442 CiteScore 1.99
Scopus rating (2014): SJR 1.089 SNIP 1.299 CiteScore 1.94
Scopus rating (2013): SJR 1.092 SNIP 1.27 CiteScore 1.93
Scopus rating (2012): SJR 1.182 SNIP 1.272 CiteScore 1.92
Scopus rating (2011): SJR 1.159 SNIP 1.318 CiteScore 1.97
Scopus rating (2010): SJR 1.105 SNIP 1.245
Scopus rating (2009): SJR 1.206 SNIP 1.397
Scopus rating (2008): SJR 1.434 SNIP 1.45
Scopus rating (2007): SJR 1.269 SNIP 1.406
Scopus rating (2006): SJR 1.297 SNIP 1.553
Scopus rating (2005): SJR 1.226 SNIP 1.471
Scopus rating (2004): SJR 1.147 SNIP 1.182
Scopus rating (2003): SJR 1.097 SNIP 1.263
Scopus rating (2002): SJR 1.039 SNIP 1.049
Scopus rating (2001): SJR 1.146 SNIP 1.15
Scopus rating (2000): SJR 1.092 SNIP 1.052
Scopus rating (1999): SJR 0.993 SNIP 1.222
Original language: English
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Research output: Scientific - peer-review › Article
New alternative route for the preparation of phosphate glasses with persistent luminescence properties

In this paper, we investigate a new alternative route for the preparation of phosphate glasses with persistent luminescence properties. Phosphate glasses within the P2O5-Na2O-CaO and P2O5-Na2O-SrO systems were prepared by a standard melting process in air by adding Sr4Al14O25:Eu2+,Dy3+ microparticles in the glass batch before melting. We found that all the investigated glasses show persistent luminescence. It is clearly shown that conventional melting in air of Sr4Al14O25:Eu2+,Dy3+ microparticles in phosphate glass batch can be a new technique to prepare phosphate glasses with persistent luminescence properties.

New routes from cellulose to textile fiber and ready products

In this paper, we investigate a new alternative route for the preparation of phosphate glasses with persistent luminescence properties. Phosphate glasses within the P2O5-Na2O-CaO and P2O5-Na2O-SrO systems were prepared by a standard melting process in air by adding Sr4Al14O25:Eu2+,Dy3+ microparticles in the glass batch before melting. We found that all the investigated glasses show persistent luminescence. It is clearly shown that conventional melting in air of Sr4Al14O25:Eu2+,Dy3+ microparticles in phosphate glass batch can be a new technique to prepare phosphate glasses with persistent luminescence properties.
**Processing and characterization of novel borophosphate glasses and fibers for medical applications**

**General information**

State: Published

Ministry of Education publication type: A1 Journal article-refereed

Organisations: Department of Electronics and Communications Engineering, Research group: Biomaterials and Tissue Engineering Group, BioMediTech, Frontier Photonics, Integrated Technologies for Tissue Engineering Research (ITTE), Equipe Verres et Céramiques, UMR-CNRS 6226, Inst. des Sciences chimiques de Rennes, Université de Rennes 1, 35042 Rennes CEDEX, France, Åbo Akademi University, Biskopsgatan 8, FI-20500 Turku, Finland, nLIGHT Corporation, Sorronrinne 9, FI-08500 Lohja, Finland, Politecnico di Torino, DISAT, Istituto di Ingegneria e Fisica dei Materiali, Corso Duca degli Abruzzi 24, I-10129 Torino, Italy

Authors: Massera, J., Shpotyuk, Y., Sabatier, F., Jouan, T., Boussard-Plédel, C., Rolland, C., Bureau, B., Petit, L., Boetti, N., Milanese, D., Hupa, L.

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Scopus rating (2013): SJR 0.822 SNIP 1.19 CiteScore 1.79
Scopus rating (2012): SJR 0.758 SNIP 1.124 CiteScore 1.64
Scopus rating (2011): SJR 0.836 SNIP 1.272 CiteScore 1.7
Scopus rating (2010): SJR 0.911 SNIP 1.128
Scopus rating (2009): SJR 0.924 SNIP 0.993
Scopus rating (2008): SJR 0.957 SNIP 1.2
Scopus rating (2007): SJR 0.95 SNIP 1.082
Scopus rating (2006): SJR 0.887 SNIP 1.158
Scopus rating (2005): SJR 0.986 SNIP 1.149
Scopus rating (2004): SJR 0.992 SNIP 1.216
Scopus rating (2003): SJR 1.362 SNIP 1.308
Scopus rating (2002): SJR 0.861 SNIP 1.051
Scopus rating (2001): SJR 1.099 SNIP 1.09
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Scopus rating (1999): SJR 1.068 SNIP 0.966

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DOIs:

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Research output: Scientific - peer-review › Article

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**Ultrathin Polyimide Membrane as Cell Carrier for Subretinal Transplantation of Human Embryonic Stem Cell Derived Retinal Pigment Epithelium**

**General information**

State: Published

Ministry of Education publication type: A1 Journal article-refereed


Nanofabrication and Adsorption Studies of Organic Molecules on Metal and Metal Alloy Surfaces as Templates for Biofunctional Applications

The nanofabrication of organic layers on metal and metal alloy surfaces was studied in this thesis by employing photoelectron spectroscopy (PES) as the main analysis method. The motivation for this research is to introduce new properties to metal and metal alloy surfaces via self-assembly driven adsorption processes of organic molecules. Trimesic acid (TMA) and glycine adsorption on single crystal Cu(100) surface was investigated with PES and scanning tunnelling microscopy (STM). TMA on Cu(100) exhibits coverage dependent surface phases with drastic changes in the molecular orientation. The mobile TMA molecules at low coverage transform into Cu atom coordinated TMA networks and finally into carboxyl (COOH) functionalized, densely packed TMA monolayers. This is enabled due to three equivalent COOH groups symmetrically around a rigid benzene ring. Homo- and heterochiral surface phases of achiral glycine on Cu(100) were observed, and a new structural model for glycine bonding on Cu(100) based on STM and density functional theory calculations is presented. The coadsorption of aminopropyl trimethoxysilane (APS) and mercaptopropyl trimethoxysilane (MPS) on stainless steel was studied with an aim to incorporate MPS in APS matrix with tuneable distribution. In addition to the determination of elemental and chemical states at the surface, PES data was also used to determine the surface morphology by employing inelastic electron energy-loss background analysis. Synchrotron radiation mediated PES enabled the study of the in-depth distribution of the chemical states in non-destructive manner. The functionality of the APS/MPS overlayers on stainless steel was studied with chemical derivatization. The studies of TMA and glycine on Cu(100) provide important knowledge of the adsorption behaviour of small molecules on surfaces, which is crucial for understanding the adsorption phenomena of larger molecules, such as proteins on more complex substrates. The fabricated surface structures may also be applicable to molecular electronics or catalytic surfaces. The bifunctional silanization of stainless steel, on the other hand, is directly transferrable to industrial scale processes. The bifunctional APS/MPS nanomolecular layer on stainless steel works as a template, to which biomolecules can be covalently coupled with tuneable distribution. Hence, the stainless steel surface can be biofunctionalized for a range of applications, depending on the properties of the biomolecules.
Development of chip-surface stimulus electrode array for fully-implantable subretinal prosthesis chip

In this study, we have developed a chip-surface stimulus electrode array for fully-implantable subretinal prosthesis chip. To realize visual restoration with high resolution, stimulus electrodes should be miniaturized and arrayed with high density. When we miniaturize them, however, their electrochemical impedances become higher and their amount of charge injection become smaller. Additionally, as the number of electrodes increases, it becomes difficult to make electrical connection to each pixel of the retinal prosthesis chip and each electrode by electrical wiring. To overcome these problems, we have developed the stimulus electrodes that have low electrochemical impedances and large charge injection capacities, and established a fabrication process of chip-surface stimulus electrode array. We fabricated the stimulus electrodes made of extremely porous platinum which had large-surface-area compared with conventional Pt. We also fabricated the chip-surface stimulus electrodes array on the subretinal prosthesis chip which surface was rough and covered with insulator film.
Development of Si neural probe module with adjustable gain amplifier for neuronal signal recording

In recent years, lots of research on biomedical technologies directly using bio-signals such as BMI (Brain Machine Interface) have been performed intensively. Among bio-signals, ECoG (Electrocorticogram), LFP (Local Field Potential), and AP (Action Potential) are usually recorded especially for diagnosis, treatment, and prevention of brain diseases. These bio-signals have different amplitudes and frequency bandwidths, and the signal intensities vary accordingly with recording electrode conditions and individual variation. Therefore, a multiple bio-signals recording system having adjustable gain and bandwidth is strongly required. In this study, we designed the adjustable gain amplifier appropriate for the system, and fabricated the module composed of the amplifier and a Si neural probe for the multiple bio-signal recording in the deep brain. Additionally, we verified fundamental functions of the module by in vitro experiments.

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Organisations: Department of Electronics and Communications Engineering, Research group: Biomaterials and Tissue Engineering Group, Research group: Computational Biophysics and Imaging Group, BioMediTech, Integrated Technologies for Tissue Engineering Research (ITTE), Graduate School of Engineering, Electrical and Electronics Engineering Department, Department of Bioengineering and Robotics, Tohoku University, Nagasaki Institute of Applied Science
Authors: Tani, T., Naganuma, H., Harashima, T., Iwagami, T., Kino, H., Kiyoyama, K., Kellomäki, M., Hyttinen, J., Tanaka, T.
Pages: O-377-O-378
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Peer-reviewed: Yes

Publication information
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Volume: 52
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Scopus rating (2014): SJR 0.124 SNIP 0.013
Scopus rating (2013): SJR 0.103 SNIP 0.393

Original language: English
ASJC Scopus subject areas: Biomedical Engineering
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Source: Scopus
Source-ID: 84939439184
Research output: Scientific - peer-review › Article
Switchable water absorption of paper via liquid flame spray nanoparticle coating

Surface wetting/anti-wetting and liquid absorption are relevant properties of many porous solids including paper and other cellulose-based materials. Here we demonstrate how surface wetting by water and water absorption of commercially available kraft paper can be altered by thin nanoparticle coatings fabricated by liquid flame spray in facile and continuous one-step process. Surface wettability and absorption properties of paper increased with silica and decreased with titania (TiO2) nanoparticle coatings. Moreover, the water-repellent (superhydrophobic) TiO2 nanoparticle coated paper could be switched to superhydrophilic and water absorbing by ultraviolet illumination. The experiments revealed that although surface wetting and liquid absorption of nanoparticle coated paper are strongly related to each other, they are two distinct phenomena which do not necessarily correlate. We propose wetting regimes on the nanoparticle coated paper samples on the basis of the experimental observations.

General information

State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Materials Science, Research group: Paper Converting and Packaging, Department of Physics, Research area: Aerosol Physics, Research group: Aerosol Synthesis, Engineering materials science and solutions (EMASS), Abo Akad Univ, Abo Akademi University, Ctr Funct Mat, Lab Paper Coating & Converting
Authors: Teisala, H., Tuominen, M., Haapanen, J., Aromaa, M., Stepien, M., Mäkelä, J. M., Saarinen, J. J., Toivakka, M., Kuusipalo, J.
Number of pages: 11
Publication date: Jun 2014

Publications information

Journal: Cellulose
Volume: 21
Issue number: 3
ISSN (Print): 0969-0239

Ratings:

Scopus rating (2016): CiteScore 3.68 SJR 1.126 SNIP 1.144
Scopus rating (2015): SJR 1.153 SNIP 1.24 CiteScore 3.55
Scopus rating (2014): SJR 1.071 SNIP 1.334 CiteScore 3.58
Scopus rating (2013): SJR 1.127 SNIP 1.48 CiteScore 3.83
Scopus rating (2012): SJR 1.179 SNIP 1.71 CiteScore 3.74
Scopus rating (2011): SJR 1.354 SNIP 1.795 CiteScore 3.99
Scopus rating (2010): SJR 0.873 SNIP 1.384
Scopus rating (2009): SJR 1.038 SNIP 1.219
Scopus rating (2008): SJR 0.926 SNIP 1.123
Scopus rating (2007): SJR 0.754 SNIP 1.034
Adjustable wetting of Liquid Flame Spray (LFS) TiO2-nanoparticle coated board: Batch-type versus roll-to-roll Stimulation methods

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Materials Science, Department of Physics, Engineering materials science and solutions (EMASS)
Authors: Tuominen, M., Teisala, H., Haapanen, J., Aromaa, M., Mäkelä, J. M., Stepien, M., Saarinen, J. J., Toivakka, M., Kuusipalo, J.
Number of pages: 9
Pages: 271-279
Publication date: 2014
Peer-reviewed: Yes

Publication information
Volume: 29
Issue number: 2
ISSN (Print): 0283-2631
Ratings:
Biofunctional hybrid materials: bimolecular organosilane monolayers on FeCr alloys

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Optoelectronics Research Centre, Research group: Surface Science, Frontier Photonics, Multi-scaled biodata analysis and modelling (MultiBAM)
Authors: Vuori, L., Leppiniemi, J., Hannula, M., Lahtonen, K., Hirsimäki, M., Nömmiste, E., Costelle, L., Hytönen, V. P., Valden, M.
Number of pages: 10
Pages: 1-10
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Nanotechnology
Volume: 25
Issue number: 43
Article number: 435603
ISSN (Print): 0957-4484
Ratings:
Scopus rating (2016): SJR 1.096 SNIP 0.814 CiteScore 2.87
Scopus rating (2015): SJR 1.18 SNIP 0.966 CiteScore 3.07
Scopus rating (2014): SJR 1.465 SNIP 1.258 CiteScore 3.09
Scopus rating (2013): SJR 1.585 SNIP 1.244 CiteScore 2.74
Scopus rating (2012): SJR 1.846 SNIP 1.306 CiteScore 3.34
Scopus rating (2011): SJR 1.892 SNIP 1.461 CiteScore 3.86
Scopus rating (2010): SJR 1.844 SNIP 1.259
Scopus rating (2009): SJR 1.819 SNIP 1.28
Scopus rating (2008): SJR 1.875 SNIP 1.333
Controlling the synergetic effects in (3-aminopropyl) trimethoxysilane and (3-mercaptopropyl) trimethoxysilane coadsorption on stainless steel surfaces

Degradation mechanisms of bioresorbable polyesters. Part 1. Effects of random scission, end scission and autocatalysis
Degradation mechanisms of bioresorbable polyesters. Part 2. Effects of initial molecular weight and residual monomer
Determination of the functionality of monolayers of aminopropyl trimethoxy silane and mercaptopropyl trimethoxy silane on stainless steel with SR-PES and chemical derivatization

General information
State: Published
Ministry of Education publication type: B2 Part of a book or another research book
Organisations: Optoelectronics Research Centre, Research group: Surface Science
Authors: Vuori, L., Hannula, M., Hirsimäki, M., Tönisoo, A., Nömmiste, E., Valden, M.
Number of pages: 2
Pages: 1-2
Publication date: 2014

Host publication information
Place of publication: Lund, Sweden
Publisher: MAX-LAB

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

General information
State: Published
Ministry of Education 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)
Authors: 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
Direct laser writing of synthetic poly(amino acid) hydrogels and poly(ethylene glycol) diacrylates by two-photon polymerization

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Integrated Technologies for Tissue Engineering Research (ITTE)
Authors: Käpylä, E., Sedlacik, T., Aydogan, D. B., Viitanen, J., Rypacek, F., Kellomäki, M.
Number of pages: 10
Pages: 280-289
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Materials Science and Engineering C: Materials for Biological Applications
Volume: 43
ISSN (Print): 0928-4931
Ratings:
Scopus rating (2016): SJR 0.857 SNIP 1.176 CiteScore 3.78
Scopus rating (2015): SJR 1.312 SNIP 1.084 CiteScore 3.13
Scopus rating (2014): SJR 0.716 SNIP 1.196 CiteScore 2.88
Scopus rating (2013): SJR 0.755 SNIP 1.346 CiteScore 3.07
Scopus rating (2012): SJR 0.832 SNIP 1.471 CiteScore 2.78
Scopus rating (2011): SJR 0.849 SNIP 1.353 CiteScore 2.93
Scopus rating (2010): SJR 0.81 SNIP 1.083
Scopus rating (2009): SJR 0.753 SNIP 1.208
Scopus rating (2008): SJR 0.796 SNIP 1.08
Scopus rating (2007): SJR 0.682 SNIP 1.035
Scopus rating (2006): SJR 0.656 SNIP 0.976
Scopus rating (2005): SJR 0.747 SNIP 1.009
Scopus rating (2004): SJR 0.639 SNIP 0.843
Scopus rating (2003): SJR 0.609 SNIP 0.7
Scopus rating (2002): SJR 0.482 SNIP 0.67
Scopus rating (2001): SJR 0.467 SNIP 0.664
Flexor tendon healing within the tendon sheath using bioabsorbable poly-l/d-lactide 96/4 suture. A histological in vivo study with rabbits

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Integrated Technologies for Tissue Engineering Research (ITTE)
Authors: Viinikainen, A., Göransson, H., Taskinen, H., Röyttä, M., Kellomäki, M., Törmääli, P., Rokkanen, P.
Number of pages: 7
Pages: 1319-1325
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Journal of Materials Science: Materials in Medicine
Volume: 25
Issue number: 5
ISSN (Print): 0957-4530
Ratings:
Scopus rating (2016): SJR 0.533 SNIP 0.739 CiteScore 2.02
Scopus rating (2015): SJR 0.738 SNIP 0.952 CiteScore 2.46
Scopus rating (2014): SJR 0.739 SNIP 1.348 CiteScore 2.52
Scopus rating (2013): SJR 0.825 SNIP 1.349 CiteScore 3.02
Scopus rating (2012): SJR 0.861 SNIP 1.305 CiteScore 2.68
Scopus rating (2011): SJR 1.006 SNIP 1.228 CiteScore 2.8
Scopus rating (2010): SJR 0.949 SNIP 1.06
Scopus rating (2009): SJR 0.817 SNIP 0.996
Scopus rating (2008): SJR 0.686 SNIP 0.997
Scopus rating (2007): SJR 0.803 SNIP 0.979
Scopus rating (2006): SJR 0.724 SNIP 1.034
Scopus rating (2005): SJR 0.548 SNIP 1.046
Scopus rating (2004): SJR 0.465 SNIP 0.955
Scopus rating (2003): SJR 1.109 SNIP 0.808
Scopus rating (2002): SJR 0.923 SNIP 1.072
Scopus rating (2001): SJR 0.755 SNIP 1.378
Scopus rating (2000): SJR 0.707 SNIP 1.048
Scopus rating (1999): SJR 0.66 SNIP 1.078
Original language: English
DOIs:
10.1007/s10856-014-5160-1

Bibliographical note
Contribution: organisation=elt,FACT1=1<br/>Portfolio EDEND: 2014-08-30<br/>Publisher name: Elsevier S.A.
Source: researchoutputwizard
Source-ID: 658
Research output: Scientific - peer-review › Article
In vitro bioluminescence used as a method for real-time inhibition zone testing for antibiotic-releasing composites

Aims: This study describes the potential of real-time bioluminescence imaging in evaluating the antibiotic efficiency of two cylinder-shaped bioabsorbable antibiotic-releasing composites by in vitro inhibition zone tests. The bacterial infections of bone tissue can cause extensive hard and soft tissue damage and decrease the efficiency of oral antibiotic therapy due to the poor blood circulation in the infected area. To overcome this problem, new, locally antibiotic-releasing biodegradable composites have been developed. Study Design & Methodology: The two composites evaluated in this study were composed of poly(L-lactide-co-ε-caprolactone) matrix, β-tricalcium phosphate ceramic and either ciprofloxacin or rifampicin antibiotic. The composites were tested with genetically modified model pathogens of osteomyelitis (Pseudomonas aeruginosa and Staphylococcus epidermidis) in vitro in inhibition zone tests using a method of real-time bioluminescence. Results: The first signs of the effect of the released ciprofloxacin or rifampicin became visible after four hours of incubation and were seen as changed bioluminescence around the composite pellet on a culture dish. Both of the composite types showed excellent effects against the sensor bacteria within the diffusion area. Bioluminescence measurements suggested that no survivor bacteria capable of evolving resistant strains were left inside the inhibition zones. The S. epidermidis bacterial strain was an inhibition sensor and P. aeruginosa was a stress sensor. Conclusion: These results highlight the potential of the composite materials against the pathogens of osteomyelitis. The approach allows continuous visual inspection of the efficacy of the antibiotics against the bacteria.
Multifunctional superhydrophobic nanoparticle coatings for cellulose-based substrates by liquid flame spray

General information
State: Published
Ministry of Education publication type: D1 Article in a trade journal
Organisations: Department of Materials Science
Authors: Teisala, H.
Number of pages: 1
Pages: 59
Publication date: 2014
Peer-reviewed: Unknown

Publication information
Journal: Materia
Issue number: 1
ISSN (Print): 1459-9694
Original language: Finnish
Links:
http://www.vuorimiesyhdistys.fi/sites/default/files/materia/pdf/Materia%201-2014_0.pdf

Bibliographical note
Contribution: organisation=mol,FACT1=1<br/>Portfolio EDEND: 2014-09-05<br/>Publisher name: Vuorimiesyhdistys
Source: researchoutputwizard
Source-ID: 1608
Research output: Professional › Article

Nanoparticle Depositon on Packaging Materials by Liquid Flame Spray: Generation of Superhydrophilic and Superhydrophobic Coatings
Optical projection tomography as a tool for 3D imaging of hydrogels

Optical projection tomography can be used to investigate spatial distribution of chondrocytes in three-dimensional biomaterial scaffolds for cartilage tissue engineering
General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Integrated Technologies for Tissue Engineering Research (ITTE)
Authors: Järvinen, E., Muhonen, V., Haaparanta, A., Kellomäki, M., Kiviranta, I.
Number of pages: 5
Pages: 1549-1553
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Bio-Medical Materials and Engineering
Volume: 24
Issue number: 3
ISSN (Print): 0959-2989
Ratings:
Scopus rating (2016): SJR 0.254 SNIP 0.415 CiteScore 0.81
Scopus rating (2015): SJR 0.334 SNIP 0.754 CiteScore 0.99
Scopus rating (2014): SJR 0.284 SNIP 0.486 CiteScore 0.94
Scopus rating (2013): SJR 0.349 SNIP 0.55 CiteScore 0.98
Scopus rating (2012): SJR 0.434 SNIP 0.73 CiteScore 1.4
Scopus rating (2011): SJR 0.424 SNIP 0.584 CiteScore 1.31
Scopus rating (2010): SJR 0.403 SNIP 0.328
Scopus rating (2009): SJR 0.367 SNIP 0.434
Scopus rating (2008): SJR 0.428 SNIP 0.543
Scopus rating (2007): SJR 0.544 SNIP 0.534
Scopus rating (2006): SJR 0.405 SNIP 0.581
Scopus rating (2005): SJR 0.295 SNIP 0.511
Scopus rating (2004): SJR 0.354 SNIP 0.831
Scopus rating (2003): SJR 0.392 SNIP 0.523
Scopus rating (2002): SJR 0.461 SNIP 0.69
Scopus rating (2001): SJR 0.373 SNIP 0.623
Scopus rating (2000): SJR 0.215 SNIP 0.32
Scopus rating (1999): SJR 0.426 SNIP 0.661
Original language: English
DOIs:
10.3233/BME-140959

Bibliographical note
Contribution: organisation=elt,FACT1=1<br/>Portfolio EDEND: 2014-06-30<br/>Publisher name: IOS Press
Source: researchoutputwizard
Source-ID: 589
Research output: Scientific - peer-review › Article

Ormocomp-Modified Glass Increases Collagen Binding and Promotes the Adherence and Maturation of Human Embryonic Stem Cell-Derived Retinal Pigment Epithelial Cells

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Optoelectronics Research Centre, Research group: Surface Science, Frontier Photonics, Integrated Technologies for Tissue Engineering Research (ITTE)
Authors: Käpylä, E., Sorkio, A., Teymouri, S., Lahtonen, K., Vuori, L., Valden, M., Skottman, H., Kellomäki, M., Juuti-Uusitalo, K.
Number of pages: 11
Pages: 1-11
Publication date: 2014
Peer-reviewed: Yes

Publication information
Paper-based microfluidics: Fabrication technique and dynamics of capillary driven surface flow

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Materials Science, Department of Physics, Engineering materials science and solutions (EMASS)
Authors: Songok, J., Tuominen, M., Teisala, H., Haapanen, J., Mäkelä, J. M., Kuusipalo, J., Toivakka, M.
Number of pages: 7
Pages: 20060-20066
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: ACS Applied Materials and Interfaces
Volume: 6
Issue number: 22
ISSN (Print): 1944-8244
Ratings:
Scopus rating (2016): SJR 2.524 SNIP 1.528
Scopus rating (2015): SJR 2.299 SNIP 1.568
Scopus rating (2014): SJR 2.126 SNIP 1.64
Scopus rating (2013): SJR 1.979 SNIP 1.543
Scopus rating (2012): SJR 2.18 SNIP 1.309
Scopus rating (2011): SJR 2.017 SNIP 1.396
Scopus rating (2010): SJR 1.571 SNIP 0.931
Original language: English
Physicochemical characterization of segmented polyurethanes prepared with glutamine or ascorbic acid as chain extenders and their hydroxyapatite composites

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Integrated Technologies for Tissue Engineering Research (ITTE)
Authors: Cetina-Diaz, S., Chan-Chan, L., Vargas-Coronado, R., Cervantes-Uc, J., Quintana-Owen, P., Paakinaho, K., Kellomäki, M., Di Silvio, L., Deb, S., Cauich-Rodriguez, J.
Number of pages: 11
Pages: 1966-1976
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Journal of Materials Chemistry B
Volume: 2
Issue number: 14
ISSN (Print): 2050-750X
Ratings:
Scopus rating (2016): CiteScore 4.8 SJR 1.46 SNIP 1.014
Scopus rating (2015): SJR 1.566 SNIP 1.163 CiteScore 5.14
Scopus rating (2014): SJR 1.331 SNIP 1.007 CiteScore 4.69
Original language: English
DOIs:
10.1039/c3tb21500h

Review on Liquid Flame Spray in paper converting: Multifunctional superhydrophobic nanoparticle coatings
Wettability of a solid surface by a liquid plays an important role in several phenomena and applications, for example in adhesion, printing, and coating. Especially, wetting of rough surfaces has attracted a considerable scientific interest in recent decades. Superhydrophobic surfaces, which possess extraordinary water repellency properties due to their low surface energy chemistry and specific nano- and microscale roughness, are of particular interest due to the great variety of potential applications ranging from self-cleaning surfaces to microfluidic devices. Here we examine functional superhydrophobic and superhydrophilic nanoparticle coatings fabricated by liquid flame spray (LFS) on cellulose-based substrate materials. The article is a review of earlier papers with some new results and conclusions added. LFS has proved itself straightforward and versatile one-step method to fabricate broad range of functional nanoparticle coatings on various substrate materials in an atmospheric roll-to-roll process. It has established itself among the most potential candidates for large-scale production of superhydrophobic coatings on affordable cellulose-based substrates.

General information
State: Published
Ministry of Education publication type: A2 Review article in a scientific journal
Organisations: Department of Materials Science, Department of Physics, Research area: Aerosol Physics, Research group: Aerosol Synthesis, Engineering materials science and solutions (EMASS)
Authors: Teisala, H., Tuominen, M., Haapanen, J., Aromaa, M., Stepien, M., Mäkelä, J. M., Saarinen, J. J., Toivakka, M., Kuusipalo, J.
Number of pages: 13
Silane-modified substratum improves cell attachment of human embryonic stem cell-derived retinal pigment epithelial cells

General information
State: Published
Ministry of Education publication type: B3 Non-refereed article in conference proceedings
Organisations: Department of Electronics and Communications Engineering, Research group: Biomaterials and Tissue Engineering Group, Optoelectronics Research Centre, Research group: Surface Science, Univ Tampere, University of Tampere, BioMediTech, BMT FM5, BioMediTech
Authors: Juuti-Uusitalo, K., Sorkio, A. E., Käpylä, E. M. K., Teymouri, S., Lahtonen, K. T., Vuori, A. M., Valden, M. O., Skottman, H., Kellomäki, M. A. E.
Pages: 3996
Publication date: 2014

Host publication information
Title of host publication: Investigative Ophthalmology & Visual Science
Volume: 55
An in vitro study of composites of poly(L-lactide-co-e-caprolactone), ß-tricalcium phosphate and ciprofloxacin intended for local treatment of osteomyelitis

Osteomyelitis is a bacterial disease that can become chronic, and treatment often includes a surgical operation to remove infected bone. The aim of this study was to develop and investigate in vitro bone filling composite materials that release ciprofloxacin to kill any remaining bacteria and contain bioceramic to help the bone to heal. Three composites of poly(L-lactide-co-e-caprolactone), ß-tricalcium phosphate and ciprofloxacin were compounded using twin-screw extrusion and sterilized by gamma irradiation. Drug release and degradation of the composites were investigated in vitro for 52 weeks. The composite with 50 wt% of ß-TCP had the most promising ciprofloxacin release profile. The ceramic component accelerated the drug release that occurred in three phases obeying first-order kinetics. Inhibition zone testing using bioluminescence showed that the released ciprofloxacin had effect in eradicating a common osteomyelitis causing bacteria Pseudomonas aeruginosa. During the in vitro degradation test series, molar weight of the polymer matrix of the composites decreased rapidly. Additionally, 1H-NMR analysis showed that the polymer had blocky structure and the comonomer ratio changed during hydrolysis. The tested composites showed great potential to be developed into bone filler materials for the treatment of osteomyelitis or other bone related infections.
Silanointiparametrien vaikutus sähkökemiallisesti passivoidun austeniittisen teräksen pinnalle rakentuvan biofunktionaalisen seosaan

This thesis examines the chemical composition of a mixed silane thin film synthesized on electrochemically passivated AISI 316L-stainless steel. Silane thin films can be used to enhance the biocompatibility of stainless steel and to create surface functionalities that promote adsorption of biomolecules. Such hybrid materials made of steel and organic coatings can be utilized in e.g. medical implants and tissue engineering.

The goal of this work was to develop deposition equipment needed for the synthesis of silane thin films in order to improve the rate and reproducibility of the sample preparation. The equipment was used to investigate the effect of silanization parameters such as the composition of the silane solution, the hydrolysis time and the silanization time on the structure of the self-assembled thin film. The silane molecules used in this study were amine terminated (3-aminopropyl)trimethoxysilane (APS) and thiol terminated (3-mercaptopropyl)trimethoxysilane (MPS).
The silanization process was conducted as a liquid phase deposition in atmospheric pressure, which enables the method to be easily adapted to commercial applications. On the other hand, the measurements were performed in ultra-high vacuum utilizing both synchrotron radiation induced and conventional X-ray photoelectron spectroscopy (XPS). The acquired spectra enabled conclusions to be made on the chemical composition and thickness of the silane films. They also provided information on the ratio and orientation of the functional groups.

According to the results, the employed silanization process enables the reproducible manufacturing of approximately one monolayer thick silane films. In addition, the amount of surface functionalities can be adjusted by modifying either the silane concentration in the hydrolysis solution or the silanization time. However, changing the hydrolysis time only affects the chemical bonding between the silane molecules and steel surface, not the total amount of functional groups. Based on the measurements with varying surface sensitivities, it was possible to conclude that the majority of functional groups point outwards. This is an important result considering the adsorption of biomolecules on the surface.

This study found that the hydrolysis rate of different silane species shows considerable variation despite the similar basic structure of the molecules. In the future, the hydrolysis behaviour should be investigated more carefully in the liquid phase. This might help to understand the hydrolysis reactions and also enhance the repeatability of the sample preparation.

General information
State: Published
Ministry of Education publication type: G2 Master's thesis, polytechnic Master's thesis
Organisations: Optoelectronics Research Centre, Research group: Surface Science
Authors: Hannula, M.
Number of pages: 105
Publication date: 2013

Publication information
Publisher: Unknown Publisher
Original language: Finnish
ASJC Scopus subject areas: Surfaces and Interfaces
Keywords: Silane, Stainless steel, 316, XPS, PES, Synchrotron, APS, MPS
Links:
http://dspace.cc.tut.fi/dpub/handle/123456789/21373
Research output: Scientific > Master's Thesis