High-speed manufacturing of antimicrobial paper

General information
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MoE publication type: A4 Article in a conference publication
Organisations: Physics, Abo Akademi University, University of Turku, Center for Functional Materials at Biological Interfaces (FUNMAT)
Contributors: Brobbey, K. J., Haapanen, J., Gunell, M., Mäkelä, J. M., Eerola, E., Saarinen, J. J., Toivakka, M.
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ASJC Scopus subject areas: Forestry, Plant Science, Industrial and Manufacturing Engineering
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Fermentative metabolism of an anaerobic, thermophilic consortium on plant polymers and commercial paper samples
The purpose of the study was to examine the feasibility and capacity of a thermophilic microbial consortium to produce fermentative metabolites from plant polymers. The consortium comprised of cellulolytic anaerobes that were originally enriched from a compost pile using cellulose as the substrate. Fermentative metabolism was examined with monosaccharides, disaccharides, hemicellulose, starch, pectin, chitin, and eight commercial paper samples without further enrichment of the culture to each specific substrate. In general, H_2, CH_4, CO_2, and organic acids were the main metabolites on all substrates but the metabolite profiles varied with the substrate. Similar H_2 yields of 2-3molmol^{-1} substrate at 48h were obtained with all monosaccharides and disaccharides. The CO_2 yields were higher with disaccharides than with monosaccharides, 4.5 vs 2molmol^{-1} substrate. Metabolite yields were relatively low with glyceraldehyde, glycerol, and arabinose. Paper samples containing high amounts of chemical pulp produced the highest metabolite yields, and biodegradation accounted for ≤74% of total dry weight loss. The fermentative metabolism of the paper samples varied with the pulp composition and the amount of inorganic material. Bacterial community analysis using pyrosequencing analysis of 16S rRNA gene showed a predominance of members of the order Clostridiales, including members of genera Clostridium and Lutispora, which contain known cellulolytic organisms. Most differences among the samples were attributed to small taxonomic groups represented by ≤10% of total sequences.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Chemistry and Bioengineering, Department of Animal Science, Ohio State University
Contributors: Carver, S. M., Nelson, M. C., Yu, Z., Tuovinen, O. H.
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Peer-reviewed: Yes

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Scopus rating (2015): CiteScore 4.03 SJR 1.51 SNIP 1.587
Original language: English
ASJC Scopus subject areas: Agronomy and Crop Science, Forestry, Renewable Energy, Sustainability and the Environment, Waste Management and Disposal
Keywords: Anaerobic biodegradation, Biohydrogen, Cellulose biodegradation, Fermentation, Plant polymers
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http://www.scopus.com/inward/record.url?scp=84923621284&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source-ID: 84923621284
Research output: Contribution to journal › Article › Scientific › peer-review

Finite element analysis of trees in the wind based on terrestrial laser scanning data

Wind damage is an important driver of forest structure and dynamics, but it is poorly understood in natural broadleaf forests. This paper presents a new approach in the study of wind damage: combining terrestrial laser scanning (TLS) data and finite element analysis. Recent advances in tree reconstruction from TLS data allowed us to accurately represent the 3D geometry of a tree in a mechanical simulation, without the need for arduous manual mapping or simplifying assumptions about tree shape. We used this simulation to predict the mechanical strains produced on the trunks of 21 trees in Wytham Woods, UK, and validated it using strain data measured on these same trees. For a subset of five trees near the anemometer, the model predicted a five-minute time-series of strain with a mean cross-correlation coefficient of 0.71, when forced by the locally measured wind speed data. Additionally, the maximum strain associated with a 5 ms^{-1} or 15 ms^{-1} wind speed was well predicted by the model (N = 17, R^2 = 0.81 and R^2 = 0.79, respectively). We also predicted the critical wind speed at which the trees will break from both the field data and models and find a good overall agreement (N = 17, R^2 = 0.40). Finally, the model predicted the correct trend in the fundamental frequencies of the trees (N = 20, R^2 = 0.38) although there was a systematic underprediction, possibly due to the simplified treatment of material properties in the model. The current approach relies on local wind data, so must be combined with wind flow modelling to be applicable at the landscape-scale or over complex terrain. This approach is applicable at the plot level and could also be applied to open-grown trees, such as in cities or parks.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Mathematics, Research group: Inverse Problems, University of Oxford, Facility for Airborne Atmospheric Measurements, Universiteit Gent, National Physical Laboratory, University College London, NERC National Centre for Earth Observation (NCEO), EFI Planted Forest Facility, Wageningen University and Research Centre, INRA
Contributors: Jackson, T., Shenkin, A., Wellpott, A., Calders, K., Origo, N., Disney, M., Burt, A., Raumonen, P., Gardiner, B., Herold, M., Fourcaud, T., Malhi, Y.
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ASJC Scopus subject areas: Forestry, Global and Planetary Change, Agronomy and Crop Science, Atmospheric Science
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Source: Scopus
Source-ID: 85056823859
Research output: Contribution to journal › Article › Scientific › peer-review

How management intensity and neighborhood composition affect the structure of beech (Fagus sylvatica L.) trees

Key message: The intensity of silvicultural interventions and the neighborhood composition determine branching patterns, crown shape, and trunk attributes of beech (Fagus sylvaticaL.) trees.Abstract: The intensity of silvicultural interventions and the composition of tree species are important forest management decisions. Both determine tree shape and thus influence the value of a tree, be it in terms of economy (trunk form, branchiness), or in terms of ecology (microhabitats). However, our knowledge on the distinct changes in tree architecture due to silvicultural management intensity or different neighborhood diversities is still limited, especially if the focus is on single tree attributes, e.g., branching patterns or crown shapes. We used terrestrial laser scanner data to calculate 25 structural measures for 55 European beech (Fagus sylvatica L.) trees that grew either in pure stands along a gradient of management intensity or in intra or interspecific neighborhoods in unmanaged stands. We found a lower height of maximal horizontal crown extension, a higher crown surface area, and straighter trunks with increasing management intensity. Moreover, our study revealed that beech trees surrounded by valuable hardwoods showed a lower height of maximal horizontal crown extension, a lower height–diameter ratio, and longer branches with flatter branch angles than beech trees surrounded by conspecific neighbors. Our findings provide evidence of phenotypic plasticity of European beech to diverse environmental conditions. The differences in tree structure indicate an increasing crown competition with decreasing management intensity and

stronger competitive pressure for beech surrounded by conspecific neighbors in comparison to alien neighbors.

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MoE publication type: A1 Journal article-refereed
Organisations: Mathematics, Research group: Inverse Problems, University of Goettingen, Department of Applied Health Research
Contributors: Juchheim, J., Annighöfer, P., Ammer, C., Calders, K., Raumonen, P., Seidel, D.
Number of pages: 13
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Publication date: 14 Jul 2017
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Scopus rating (2017): CiteScore 1.88 SJR 0.726 SNIP 0.945
Original language: English
ASJC Scopus subject areas: Forestry, Physiology, Ecology, Plant Science
Keywords: Competition, Crown plasticity, Quantitative structural models, Terrestrial laser scanning, Thinning, Tree architecture
DOIs:

10.1007/s00468-017-1581-z
Source: Scopus
Source-ID: 85023781959
Research output: Contribution to journal › Article › Scientific › peer-review

Applicability of portable tools in assessing the bearing capacity of forest roads
Forest roads provide access to logging sites and enable transportation of timber from forest to mills. Efficient forest management and forest industry are impossible without a proper forest road network. The bearing capacity of forest roads varies significantly by weather conditions and seasons since they are generally made of poor materials and the constructed layers may be mixed with subgrade. A bearing capacity assessment is valuable information when trafficability is uncertain and rutting is obvious. In this study, bearing capacity measurements were carried out using the light falling weight deflectometer (LFWD), the dynamic cone penetrometer (DCP) and the conventional falling weight deflectometer (FWD). The aim was to compare their measurement results in relation to road characteristics and moisture conditions. Data were collected from 35 test road sections in four consecutive springs and during one summer. The test road sections had measurement points both on the wheel path and the centre line. The data show logical correlations between measured quantities, and the study presents reliable regression models between measuring devices. The results indicate that light portable tools, the DCP and the LFWD, can in most cases be used instead of the expensive falling weight deflectometer on forest roads.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Department of Civil Engineering, Research group: Earth Constructions, Life Cycle Effectiveness of the Built Environment (LCE@BE), Natural Resources Institute Finland (Luke), Natural Resources Institute Finland
Contributors: Kaakkurivaara, T., Vuorimies, N., Kolisoja, P., Uusitalo, J.
Number of pages: 26
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Issue number: 2
Article number: 1239
ISSN (Print): 0037-5330
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Scopus rating (2015): CiteScore 1.46 SJR 0.64 SNIP 1.019
Original language: English
ASJC Scopus subject areas: Ecological Modelling, Forestry
Keywords: Dynamic cone penetrometer, Elastic modulus, Falling weight deflectometer, Light weight deflectometer, Stiffness

DOIs:
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Source: Scopus
Source-ID: 84929222878
Research output: Contribution to journal › Article › Scientific › peer-review

Fly ash in forest road rehabilitation

Finnish forestry and bioenergy production is seeking novel uses for the fly ash deriving from biomass conversion. There are various possibilities for using fly ash in civil engineering including road construction. The increase in bioenergy production has created more interest for using ash in forest roads. However, no established methods for the rehabilitation of forest roads exist yet. Hence, this research aims to find a suitable construction method that involves using ash that provides adequate bearing capacity. It involved building ten test road sections: two of them were reference sections without fly ash. The study examined the effect of four different rehabilitation methods on the bearing capacity of roads. Measurements were made once before and four times after the rehabilitation. The measuring devices included a light falling weight deflectometer (LFWD), a dynamic cone penetrometer (DCP) and a conventional falling weight deflectometer (FWD). Two of the rehabilitation structures were 50 and 25 cm thick fly ash layers. The other two were 15 and 20 cm thick layers made of fly ash and aggregate in different mixing ratios. In all cases, the constructed layers were paved with aggregate. Statistical comparison showed that the bearing capacity of the rehabilitated road sections had improved compared to the reference sections. The recorded bearing capacities after rehabilitation (during spring thaw in 2012, 2013 and 2014) were about the same as before rehabilitation in summer 2011. Based on this study, fly ash can be recommended as an option for forest road rehabilitation.

General information

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MoE publication type: A1 Journal article-refereed
Organisations: Department of Civil Engineering, Research area: Infrastructure Construction, Research group: Earth Constructions, Natural Resources Institute Finland (Luke)
Contributors: Kaakkurivaara, T., Kolisoja, P., Uusitalo, J., Vuorimies, N.
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Publication information

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ASJC Scopus subject areas: Forestry
Keywords: Bearing capacity, Fly ash, Forest road, Rehabilitation
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Kaakkurivaara_et_al_fly_ash
URLs:
http://www.crojfe.com/r/i/crojfe_37-1_2016/Kaakkurivaara.pdf
http://urn.fi/URN:NBN:fi:tty-201705191419
Source: Scopus
Source-ID: 84959135997
Research output: Contribution to journal › Article › Scientific › peer-review

Comparison of wood volume estimates of young trees from terrestrial laser scan data

Many analyses in ecology and forestry require wood volume estimates of trees. However, non-destructive measurements are not straightforward because trees are differing in their three-dimensional structures and shapes. In this paper we compared three methods (one voxel-based and two cylinder-based methods) for wood volume calculation of trees from point clouds obtained by terrestrial laser scanning. We analysed a total of 24 young trees, composed of four different species ranging between 1.79 m to 7.96 m in height, comparing the derived volume estimates from the point clouds with xylometric reference volumes for each tree. We found that both voxel-and cylinder-based approaches are able to compute wood volumes with an average accuracy above 90% when compared to reference volumes. The best results were achieved with the voxel-based method (r^2 = 0.98). Cylinder-model based methods (r^2 = 0.90 and 0.92 respectively) did perform slightly less well but offer valuable additional opportunities to analyse structural parameters for each tree. We found that the error of volume estimates from point clouds are strongly species-specific. Therefore, species-specific parameter sets for point-cloud based wood volume estimation methods are required for more robust estimates across a number of tree species.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Mathematics, Research group: Inverse Problems, Vodafone Department of Mobile Communications Systems, Leuphana University Lüneburg, INRA Centre de Nancy
Contributors: Kunz, M., Hess, C., Raumonen, P., Bienert, A., Hackenberg, J., Maas, H. G., Härdtle, W., Fichtner, A., Von Oheimb, G.
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Journal: iForest - Biogeosciences and Forestry
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Original language: English
ASJC Scopus subject areas: Forestry, Ecology, Nature and Landscape Conservation
Keywords: Mixed forests, Quantitative structure models, Voxel-based, Xylometry
Electronic versions:

Comparison of wood volume estimates of young trees from terrestrial laser scan data
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10.3832/ifor2151-010
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Source: Scopus
Source-ID: 85019560771
Research output: Contribution to journal › Article › Scientific › peer-review

Planning land use for biogas energy crop production: The potential of cutaway peat production lands
Each year, thousands of hectares of peatland that had been harvested are being released in Finland, which can offer an opportunity to increase energy crops and attain the bioenergy targets for non-agriculture lands. In this study, the Geographic Information System (GIS) method was used to improve the assessment of decentralized renewable energy resources. The amount of peat production lands and future cutaway areas for energy crop production was calculated as a case study by using ArcGIS and the Finnish Topographic database. There are almost 1000 km^2 of peat production lands in Finland, and theoretically, approximately 300 km^2 of cutaway peatlands could be used for energy crops after 30 years. The dry biomass yield of reed canary grass (Phalaris arundinacea) or timothy-fescue grass (mix of Phleum pratense and Festuca pratensis) could be higher than 100 Gg a^{-1} in these lands indicating methane potential of approximately 300 GWh. The exhausted peat production areas in the western region of Finland have significant potential for use for energy crops; North and South Ostrobothnia account for almost 45% of the total peat production land. A future goal could be to use the cutaway peat production lands more efficiently for bioenergy to mitigate climate change. Since the use of wastelands (including peatlands) are being considered in Europe as a way to avoid competition with food production, the GIS method used in the study to identify suitable peat lands could be applicable to biomass resource studies being conducted in many countries.

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MoE publication type: A1 Journal article-refereed
Organisations: Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry, University of Jyväskylä
Contributors: Laasasenaho, K., Lensu, A., Rintala, J.
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Peer-reviewed: Yes

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Scopus rating (2016): CiteScore 3.71 SJR 1.198 SNIP 1.385

Original language: English
ASJC Scopus subject areas: Agronomy and Crop Science, Forestry, Renewable Energy, Sustainability and the Environment, Waste Management and Disposal
Keywords: Bioenergy, Festuca pratensis, GIS, Phalaris arundinacea, Phleum pratense, Wasteland
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Source: Scopus
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Research output: Contribution to journal › Article › Scientific › peer-review

Landowners' willingness to promote bioenergy production on wasteland − future impact on land use of cutaway peatlands
Landowners are the key players in bioenergy production on wasteland; such as cutaway peatlands. In this study, the landowner's interest to use cutaway peatlands for bioenergy production was investigated using a survey and GIS (Geographic Information Systems) methods in an area in South Ostrobothnia, Finland. The focus was to identify which different bioenergy production chains are preferred by the respondents: combustion, gasification or biogas production from agriculture, energy-willow short-rotation forestry or forestry based energy crops. Also, the influence of personal environmental values on the selection was measured and the future impacts and barriers for the land use were assessed. Afforestation was the most popular after-use method among the landowners. The next most favorable method was energy crop cultivation but it was highly dependent on economic profitability and subsidies. Currently, approximately 8.2% or 500 ha of the total peat extraction area could be used for bioenergy production in the region by 2035. Based on the survey, forest based biomass is the best option if bioenergy is to be produced. The next choice was agro biomass and the least favored plant was willow. This study suggests that the biggest cutaway peatlands will be converted to forest energy in the future. Suggestive results were that the owners with high environmental values are especially interested in agro biomass growing and the landowner having a distant home place does not have a negative influence on bioenergy production. Altogether, land use and biomass production of cutaway peatlands is connected with the demands of the Finnish bio-economy.

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Organisations: Chemistry and Bioengineering, Research group: Bio- and Circular Economy, Jyväskylän yliopisto, Seinäjoki University of Applied Sciences
Contributors: Laasasenaho, K., Lensu, A., Rintala, J., Lauhanen, R.
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ASJC Scopus subject areas: Forestry, Geography, Planning and Development, Nature and Landscape Conservation, Management, Monitoring, Policy and Law
Keywords: Biogas, Combustion, Energy crop, Gasification, GIS, Willow
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Source: Scopus
Source-ID: 85029532718
Research output: Contribution to journal › Article › Scientific › peer-review

Exposure to biological and chemical agents at biomass power plants
The increasing use and production of bioenergy means that the number of employees working in this area will inevitably grow, making it ever more important to know the health and safety issues involved in the biomass supply chain. Our aim was to determine the exposure of employees to biological and chemical agents during various work tasks at different biomass-fuelled power plants in Finland. The study included technical surveys on biomass operations and occupational measurements at three CHP plants. Workers' main health risks were bacteria and fungi, which were easily spread to the air during heavy biomass processes. The exposure levels of actinobacteria, bacterial endotoxins and fungi were high, especially during the unloading of peat and wood chips. In addition, workers were exposed to mechanical irritation caused

by organic dust, and chemical irritation caused by volatile organic compounds and components of diesel exhausts. Multiple exposures to these agents may simultaneously have synergistic health effects on workers' lower and upper respiratory tracts. During operations, workers were also exposed to endotoxins, actinobacteria and fungi, especially during the cleaning and handling of wood chips in silos and while working near screens or crushers. The measured concentrations exceeded the limit values proposed for these agents. The highest concentration of volatile organic compounds was found near conveyors. On the basis of these measurements, we suggested best practices for the power plants. The levels of biological agents in outdoor measurements reflected only low spreading of contaminants from power plants to the environment.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Research group: Environmental Health, Tyoterveyslaitos, VTT Technical Research Centre of Finland, Finnish Institute of Occupational Health, University of Eastern Finland
Contributors: Laitinen, S., Laitinen, J., Fagernäs, L., Korpijärvi, K., Korpinen, L., Ojanen, K., Aatamila, M., Jumpponen, M., Koponen, H., Jokiniemi, J.
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Original language: English
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Source: Scopus
Source-ID: 84977492787
Research output: Contribution to journal › Article › Scientific › peer-review

Quantifying branch architecture of tropical trees using terrestrial LiDAR and 3D modelling
Key message: A method using terrestrial laser scanning and 3D quantitative structure models opens up new possibilities to reconstruct tree architecture from tropical rainforest trees. Abstract: Tree architecture is the three-dimensional arrangement of above ground parts of a tree. Ecologists hypothesize that the topology of tree branches represents optimized adaptations to tree's environment. Thus, an accurate description of tree architecture leads to a better understanding of how form is driven by function. Terrestrial laser scanning (TLS) has demonstrated its potential to characterize woody tree structure. However, most current TLS methods do not describe tree architecture. Here, we examined nine trees from a Guyanese tropical rainforest to evaluate the utility of TLS for measuring tree architecture. First, we scanned the trees and extracted individual tree point clouds. TreeQSM was used to reconstruct woody structure through 3D quantitative structure models (QSMs). From these QSMs, we calculated: (1) length and diameter of branches > 10 cm diameter, (2) branching order and (3) tree volume. To validate our method, we destructively harvested the trees and manually measured all branches over 10 cm (279). TreeQSM found and reconstructed 95% of the branches thicker than 30 cm. Comparing field and QSM data, QSM overestimated branch lengths thicker than 50 cm by 1% and underestimated diameter of branches between 20 and 60 cm by 8%. TreeQSM assigned the correct branching order in 99% of all cases and reconstructed 87% of branch lengths and 97% of tree volume. Although these results are based on nine trees, they validate a method that is an important step forward towards using tree architectural traits based on TLS and open up new possibilities to use QSMs for tree architecture.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Mathematics, Research group: Inverse Problems, Wageningen University and Research Centre, Center for International Forestry Research (CIFOR), Sonoma State University, University of Oxford

Contributors: Lau, A., Bentley, L. P., Martius, C., Shenkin, A., Bartholomeus, H., Raumonen, P., Malhi, Y., Jackson, T., Herold, M.
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ASJC Scopus subject areas: Forestry, Physiology, Ecology, Plant Science
Keywords: Destructive harvesting, Quantitative structure models, Terrestrial LiDAR, Tree architecture, Tree metrics
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DOIs:

10.1007/s00468-018-1704-1
URLs:

http://urn.fi/URN:NBN:fi:tty-201806212008
Source: Scopus
Source-ID: 85047390214
Research output: Contribution to journal › Article › Scientific › peer-review

Tree biomass equations from terrestrial LiDAR: A case study in Guyana
Large uncertainties in tree and forest carbon estimates weaken national efforts to accurately estimate aboveground biomass (AGB) for their national monitoring, measurement, reporting and verification system. Allometric equations to estimate biomass have improved, but remain limited. They rely on destructive sampling; large trees are under-represented in the data used to create them; and they cannot always be applied to different regions. These factors lead to uncertainties and systematic errors in biomass estimations. We developed allometric models to estimate tree AGB in Guyana. These models were based on tree attributes (diameter, height, crown diameter) obtained from terrestrial laser scanning (TLS) point clouds from 72 tropical trees and wood density. We validated our methods and models with data from 26 additional destructively harvested trees. We found that our best TLS-derived allometric models included crown diameter, provided more accurate AGB estimates (R^2 = 0.92-0.93) than traditional pantropical models (R^2 = 0.85-0.89), and were especially accurate for large trees (diameter > 70 cm). The assessed pantropical models underestimated AGB by 4 to 13%. Nevertheless, one pantropical model (Chave et al. 2005 without height) consistently performed best among the pantropical models tested (R^2 = 0.89) and predicted AGB accurately across all size classes-which but for this could not be known without destructive or TLS-derived validation data. Our methods also demonstrate that tree height is difficult to measure in situ, and the inclusion of height in allometric models consistently worsened AGB estimates. We determined that TLS-derived AGB estimates were unbiased. Our approach advances methods to be able to develop, test, and choose allometric models without the need to harvest trees.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Computing Sciences, Research group: Inverse Problems, Wageningen University and Research Centre, 16 Center for International Forestry Research (CIFOR), Universiteit Gent, Center for International Forestry Research (CIFOR) Germany, University College London, Guyana Forestry Commission, Swedish University of Agricultural Sciences
Contributors: Lau, A., Calders, K., Bartholomeus, H., Martius, C., Raumonen, P., Herold, M., Vicari, M., Sukhdeo, H., Singh, J., Goodman, R. C.
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Electronic versions:

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

Screening boreal energy crops and crop residues for methane biofuel production

The purpose of the study was to screen potential boreal energy crops and crop residues for their suitability in methane production and to investigate the effect of harvest time on the methane production potential of different crops. The specific methane yields of crops, determined in 100-200 d methane potential assays, varied from 0.17 to 0.49 m^3 CH_4 kg^{-1} VS added (volatile solids added) and from 25 to 260 m^3 CH_4 t_{ww}^{-1} (tonnes of wet weight). Jerusalem artichoke, timothy-clover grass and reed canary grass gave the highest potential methane yields of 2900-5400 m^3 CH_4 ha^{-1}, corresponding to a gross energy yield of 28-53 MWh ha^{-1} and ca. 40,000-60,000 km ha^{-1} in passenger car transport. The effect of harvest time on specific methane yields per VS of crops varied a lot, whereas the specific methane yields per t_{ww} increased with most crops as the crops matured.

General information

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MoE publication type: A1 Journal article-refereed
Organisations: Jyväskylän yliopisto, University of Jyväskylä
Contributors: Lehtomäki, A., Viinikainen, T. A., Rintala, J. A.
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Pages: 541-550
Publication date: Jun 2008
Peer-reviewed: Yes

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Original language: English
ASJC Scopus subject areas: Agronomy and Crop Science, Forestry, Renewable Energy, Sustainability and the Environment
Keywords: Anaerobic digestion, Crop residues, Energy crops, Harvest time, Maturity stage, Methane production
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Source-ID: 44249103064
Research output: Contribution to journal › Article › Scientific › peer-review

Classifying soil stoniness based on the excavator boom vibration data in mounding operations

The stoniness index of forest soil describes the stone content in the upper soil layer at depths of 20–30 centimeters. This index is not available in any existing map databases, and traditional measurements for the stoniness of the soil have always necessitated laborious soil-penetration methods. Knowledge of the stone content of a forest site could be of use in a variety of forestry operations. This paper presents a novel approach to obtaining automatic measurements of soil stoniness during an excavator-based mounding operation. The excavator was equipped with only a low-cost inertial measurement unit and a satellite navigation receiver. Using the data from these sensors and manually conducted soil stoniness measurements, supervised machine learning methods were utilized to build a model that is capable of predicting the stoniness class of a given mounding location. This study compares different classifiers and feature selection methods to find the most promising solution for this learning problem. The discussion includes a proposition for a meaningful measurement resolution of the soil’s stoniness, and a practical method for evaluating the variability of the stone content of the soil. The results indicate that it is possible to predict the soil stoniness class with 70% accuracy using only the inertial and location measurements.

General information

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Organisations: Automation Technology and Mechanical Engineering, Metsäteho Oy
Contributors: Melander, L., Ritala, R., Strandström, M.
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ASJC Scopus subject areas: Forestry, Ecological Modelling
Keywords: Activity recognition, Spot mounding, Stoniness classification, Supervised machine learning
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Source-ID: 85067380233
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The role of base substrate on barrier and convertability properties of Water based barrier coated (WBBC) paper and paperboard

Water based barrier coatings (WBBC) have been studied intensively during the past years in order to replace the traditional barrier materials such as polyethylene (PE), flurochemicals and waxes. One of the largest challenges for these WBBC's has been a high risk for pinholes originating from the base substrate leading into discontinuity in the dispersion layer and poorer barrier properties. By increasing the coat weight, the amount of pinholes can be reduced but this may lead into economical and quality issues, thus optimization is needed. In this study, the role of base material in dispersion coverage and resulting barrier properties was investigated by characterizing different base materials. The barrier properties analyzed were grease and oil resistance and water and water vapour barrier, also convertability properties were examined. The results showed that base substrate plays a key role when WBBC's are used. If the structure of the base paper is very open or very rough, gaining good barrier properties is difficult and the amount of pinholes increases which affects most significantly grease resistance. With very porous and rough base material best possible barrier properties at certain total coat weight were reached by double coating and by using pigments with high aspect ratio.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Materials Science, Research group: Paper Converting and Packaging, CH-Polymers Oy
Contributors: Miettinen, P., Ahokas, M., Engström, T., Heinonen, J., Auvinen, S.
Number of pages: 13
Pages: 220-232
Publication date: 2017

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Title of host publication: Paper Conference and Trade Show, PaperCon 2017 : Renew, Rethink, Redefine the Future, Minneapolis, Minnesota, USA, 23-26 April 2017
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Publisher: TAPPI Press
ISBN (Electronic): 9781510847286
ASJC Scopus subject areas: Forestry, Plant Science, Industrial and Manufacturing Engineering
URLs:

http://toc.proceedings.com/36006webtoc.pdf
Source: Scopus
Source-ID: 85041534325
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

The economics of renewable CaC_2 and C_2H_2 production from biomass and CaO

This article presents the economics of a bio-based CaC_2/C_2H_2 production concept plant. The aim of the research was to study if renewable CaC_2/C_2H_2 production could be competitive in comparison with current technologies. The starting

point was to integrate a wood char production unit into a combined heat and power (CHP) plant with a bubbling fluidized bed (BFB) boiler. The wood char was reacted with CaO in an electric arc furnace (EAF). The production costs of the CaC_2 were determined based on the wood char production costs as well as the EAF electric power consumption. The results showed that the C_2H_2 yield (18%) is similar to the current fossil-based production. However, the production costs proved to be even higher than the current selling prices of CaC_2 and C_2H_2. With the chosen basic feedstock (20 €/MWh) and electricity prices (45 €/MWh) the production costs of CaC_2 were calculated to be 725 €/t and for C_2H_2 1805 €/t. The cost effectiveness of the concept plant was determined using the payback time method including the time value of money. The break even selling prices were 747–920 €/t for the CaC_2 and 1940–3015 €/t for C_2H_2 depending on the desired payback time (4–30 years). The key factors in the production costs of CaC_2 and C_2H_2 are the price of electricity and the electrical efficiency of the EAF. The results also showed that recycling the Ca at the site could save up to 48% in fresh Ca material costs.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Chemistry and Bioengineering, Test Rig Finland, Inc.
Contributors: Pääkkönen, A., Tolvanen, H., Kokko, L.
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Early online date: 10 Nov 2018

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Original language: English
ASJC Scopus subject areas: Forestry, Renewable Energy, Sustainability and the Environment, Agronomy and Crop Science, Waste Management and Disposal
Keywords: /C, H, Poly-generation, Renewable CaC, Renewable chemicals, Techno-economic evaluation
DOIs:
10.1016/j.biombioe.2018.10.020
Source: Scopus
Source-ID: 85056214971
Research output: Contribution to journal › Article › Scientific › peer-review

One-stage H2 and CH4 and two-stage H2 + CH4 production from grass silage and from solid and liquid fractions of NaOH pre-treated grass silage
In the present study, mesophilic CH_4 production from grass silage in a one-stage process was compared with the combined thermophilic H_2 and mesophilic CH_4 production in a two-stage process. In addition, solid and liquid fractions separated from NaOH pre-treated grass silage were also used as substrates. Results showed that higher CH_4 yield was obtained from grass silage in a two-stage process (467 ml g^{-1} volatile solids $(VS)_{original}$) compared with a one-stage process (431 ml g^{-1} $VS_{original}$). Similarly, CH_4 yield from solid fraction increased from 252 to 413 ml g^{-1} $VS_{original}$ whereas CH_4 yield from liquid fraction decreased from 82 to 60 ml g^{-1} $VS_{original}$ in a two-stage compared to a one-stage process. NaOH pre-treatment increased combined H_2 yield by 15% (from 5.54 to 6.46 ml g^{-1} $VS_{original}$). In contrast, NaOH pre-treatment decreased the combined CH_4 yield by 23%. Compared to the energy value of CH_4 yield obtained, the energy value of H_2 yield remained low. According to this study, highest CH_4 yield (495 ml g^{-1} $VS_{original}$) could be obtained, if grass silage was first pre-treated with NaOH, and the separated solid fraction was digested in a two-stage (thermophilic H_2 and mesophilic CH_4) process while the liquid fraction could be treated directly in a one-stage CH_4 process.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Jyväskylän yliopisto, University of Jyväskylä
Contributors: Pakarinen, O. M., Tähti, H. P., Rintala, J. A.
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Pages: 1419-1427
Publication date: Oct 2009
Peer-reviewed: Yes

Publication information
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Volume: 33
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ISSN (Print): 0961-9534
Ratings:
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Original language: English
ASJC Scopus subject areas: Agronomy and Crop Science, Forestry, Renewable Energy, Sustainability and the Environment, Waste Management and Disposal
Keywords: Alkaline treatment, Dark fermentation, Grass silage, Hydrogen, Methane, Two-stage
DOIs:
10.1016/j.biombioe.2009.06.006
Source: Scopus
Source-ID: 69449103697
Research output: Contribution to journal › Article › Scientific › peer-review

Data-based stochastic modeling of tree growth and structure formation

We introduce a general procedure to match a stochastic functional-structural tree model (here LIGNUM augmented with stochastic rules) with real tree structures depicted by quantitative structure models (QSMs) based on terrestrial laser scanning. The matching is done by iteratively finding the maximum correspondence between the measured tree structure and the stochastic choices of the algorithm. First, we analyze the match to synthetic data (generated by the model itself), where the target values of the parameters to be estimated are known in advance, and show that the algorithm converges properly. We then carry out the procedure on real data obtaining a realistic model. We thus conclude that the proposed stochastic structure model (SSM) approach is a viable solution for formulating realistic plant models based on data and accounting for the stochastic influences.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Department of Mathematics, Research group: MAT Inverse Problems
Contributors: Potapov, I., Järvenpää, M., Åkerblom, M., Raumonen, P., Kaasalainen, M.
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Article number: 1413
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Ratings:
Scopus rating (2016): CiteScore 1.45 SJR 0.702 SNIP 1.116
Original language: English
ASJC Scopus subject areas: Ecological Modelling, Forestry
Keywords: Data fitting, Form diversity, Morphological plasticity, Plant model, Quantitative structure models, Stochastic functional-structural, Terrestrial lidar
DOIs:
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Source: Scopus
Source-ID: 84983200698
Research output: Contribution to journal › Article › Scientific › peer-review

Influence of nutrient deprivations on lipid accumulation in a dominant indigenous microalga Chlorella sp., BUM11008: Evaluation for biodiesel production

Microalgae are a potential source of biodiesel. The urgent need for an alternative and sustainable energy has created renewed interest to analyze the microalgae for biodiesel production. In this study, a dominant indigenous freshwater unicellular microalgal strain Chlorella sp., BUM11008, was examined for its efficiency towards biodiesel production. The organism was evaluated for ability to yield high of biomass and lipid productivity under normal and various nutrient-deprived conditions (nitrogen, phosphate-potassium, iron, and all three combined). Under normal conditions, after 20days of cultivation in Chu10 medium, the organism yielded a biomass of 2.58±0.07g/L, with lipid content of 312.16±2.38mg/g. In a two-phase culturing system upon nutrition deprivation, the organism was able to respond with different levels of lipid accumulation. Among the various post-harvest treatments, nitrogen deprivation yielded the highest lipid productivity of 53.96±0.63mg/Ld, followed by the combined deprivation condition (49.16±1.36mg/Ld). FAME profiles of the isolate were found to meet the requirements of international standards for biodiesel. The study leads to the conclusion that the two-phase culturing system with nitrogen starvation as post-harvest treatment would be suitable for gaining maximum biomass productivity, and lipid content of high quality fatty acids. Thus, it is proposed that Chlorella sp., BUM11008, would be a promising candidate for sustainable biodiesel production.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Urban circular bioeconomy (UrCirBio), Bharathidasan University, King Saud University
Contributors: Praveenkumar, R., Shameera, K., Mahalakshmi, G., Akbarsha, M. A., Thajuddin, N.
Number of pages: 7
Pages: 60-66
Publication date: Feb 2012
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Ratings:

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Original language: English
ASJC Scopus subject areas: Agronomy and Crop Science, Forestry, Renewable Energy, Sustainability and the Environment, Waste Management and Disposal
Keywords: Chlorella sp., FAME profiles, Microalgal biodiesel, Nitrogen deprivation, Nutrient deprivation
DOIs:

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Source: Scopus
Source-ID: 84856231118
Research output: Contribution to journal › Article › Scientific › peer-review

How and why does willow biochar increase a clay soil water retention capacity?
Addition of biochar into a soil changes its water retention properties by modifying soil textural and structural properties. In addition, internal micrometer-scale porosity that is able to directly store readily plant available water affects soil water retention properties. This study shows how precise knowledge of the internal micrometer-scale pore size distribution of biochar can deepen the understanding of the biochar-water interactions in soils. The micrometer-scale porosity of willow biochar was quantitatively and qualitatively characterized using X-ray tomography, 3D image analysis and Helium ion microscopy. The effect of biochar application on clay soil water retention was studied by conventional water retention curve approach. The results indicate that the internal pores of biochar, with sizes of at 50 and 10 μm (equivalent pore diameter), increased soil porosity and the amount of readily plant available water. After biochar addition, changes in soil porosity were detected at pore size regimes 5–10 and 25 μm, i.e. biochar pore sizes multiplied by factor 0.5. The detected pore size distribution of biochar does not predict directly (1:1 compatibility) the changes observed in the soil moisture characteristics. It is likely that biochar chemistry and pore morphology affect biochar-water interactions via e.g. surface roughness and contact angle. In addition, biochar induced changes in soil structure and texture affected soil moisture characteristics. However, the approach presented is an attractive pathway to more generalized understanding on how and why biochar internal porosity affects soil moisture characteristics.

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Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Faculty of Biomedical Sciences and Engineering, Research group: Computational Biophysics and Imaging Group, Natural Resources Institute Finland (Luke), Jyväskylän yliopisto
Contributors: Rasa, K., Heikkinen, J., Hannula, M., Arstila, K., Kulju, S., Hyväluoma, J.
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Scopus rating (2018): CiteScore 3.96 SJR 1.072 SNIP 1.26
Original language: English
ASJC Scopus subject areas: Forestry, Renewable Energy, Sustainability and the Environment, Agronomy and Crop Science, Waste Management and Disposal
Keywords: 3D image analysis, Biochar, Helium ion microscopy, Plant available water, Soil water retention, X-ray tomography
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EXT="Kulju, Sampo"
Source: Scopus
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Research output: Contribution to journal › Article › Scientific › peer-review

Online quality evaluation of tissue paper structure on new generation tissue machines
At present, the tissue paper manufacturing is mostly based on the dry crepe technology. During the last decade, the manufacturers have introduced new tissue machines concepts that increase the softness, bulk, and absorption capacity. Such machines produce a strong regular three-dimensional (3D) structure to the sheet before the Yankee cylinder. At present, the quality of the 3D structure is not evaluated, or it is evaluated only subjectively at the mill. This is mostly because of the difficulties to separate reliably the regular 3D pattern from other variations. This paper introduces a frequency analysis based method which separates the surface profile variances in tissue paper to the creping, to the regular 3D pattern and to the residual variation. The 3D surface profiles and their variances were determined online with the photometric stereo method. We show that the introduced analysis method evaluates the variance portions reliably and the results are consistent with the visual perception of the 3D surfaces. In one particular product, the regular 3D pattern explains 74 % of total surface variance; the creping explains 10 % and residual variations 16 %. Furthermore, the creping and residual variances are quite stable over time whereas the variance of the regular 3D pattern fluctuates significantly.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Automation and Hydraulic Engineering, Research group: Robotics and Automation, Valmet Technologies Oy
Contributors: Raunio, J., Löyttyniemi, T., Ritala, R.
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ASJC Scopus subject areas: Forestry, Materials Science(all)
Keywords: frequency analysis, photometric stereo, regular 3D structure, tissue paper
DOIs:
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Source: Scopus
Source-ID: 85047979196
Research output: Contribution to journal › Article › Scientific › peer-review

Evaluating the contrast of planar periodic patterns on paper
Certain paper products contain functional or' decorative periodic patterns. Such patterns can be e.g. the 3 D structure variations in tissue paper or the decorative sfructure 'n tobacco paper. At present, the contrast of such patterns is not measured online and thus the uniformity of the end-products may vary.Trus paper Introduces two contrast estimation methods based on Fourier and histogram analysis. The performance of the estimation methods was evaluated with the reference results made by the human panel. It was noticed that both methods estimate the contrast rather reliably. However, if the wavelength of the pattern was close to the size of the image, the Fourier method was not working appropriately. The image data available in this work was collected online at the tobacco and tissue paper machines. The tobacco paper was measured with light transmittance imaging system and the tissue paper was measured with photometric stereo imaging system that estimates the 3 D surface of the paper. It was noticed that the present imaging systems can be utilized as sUch in the estimation of contrast.

General information
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Organisations: Automation and Hydraulic Engineering, Valmet Automation Oy
Contributors: Raunio, J., Makela, I., Mäntylä, M., Ritala, R.
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ASJC Scopus subject areas: Forestry, Plant Science, Industrial and Manufacturing Engineering
Source: Scopus
Source-ID: 85060386224
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Methane production from maize in Finland - Screening for different maize varieties and plant parts
The objective of the study was to determine how the harvest time and maize variety (12 varieties) affects the methane yield and dry matter yield per hectare in southern Finland (Piikkiö) and in Central Finland (Laukaa). The specific methane yields and methane yields per hectare were also determined for different plant parts (stem, leaves and cobs). The methane yield per hectare varied from 2130 to 9170 m^3 ha^{-1}. The methane yields per hectare were ~50% lower in Laukaa than in Piikkiö due to a shorter growing season and lower total solid (TS) yields. TS yields were on average 16.7 and 15.5 Mg ha^{-1} in Piikkiö and 8.7 and 6.8 Mg ha^{-1} in Laukaa in 2007 and 2008, respectively. The specific methane yields varied from 366 to 491 dm^3 kg^{-1} volatile solid (VS) in 2007 and from 296 to 373 dm^3 kg^{-1} VS in 2008. The harvest time and sowing time did not affect the specific methane yields ($p \geq 0.05$). Whole maize crops produced more methane in batch assays than stem (372 dm^3 kg^{-1} VS), leaves (334 dm^3 kg^{-1} VS) and cobs (421 dm^3 kg^{-1} VS) alone, and also the specific methane yields per hectare were higher than the methane yield per hectare calculated for the various plant parts. Maize cultivation for biogas production appears to be feasible only in southern Finland. © 2012 Elsevier Ltd.

General information
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Organisations: Tampere University of Technology, Urban circular bioeconomy (UrCirBio), Jyväskylän yliopisto, MTT Agrifood Research Finland, Plant Production Research Horticulture, University of Jyväskylä, Department of Chemistry and Bioengineering
Contributors: Seppälä, M., Pyykkönen, V., Laine, A., Rintala, J.
Number of pages: 9
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Keywords: Biogas, Biomass, Maize, Methane production, Plant parts
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International Conference on Lignocellulosic ethanol
Contribution: organisation=keb bio,FACT1=1
Source: researchoutputwizard
Source-ID: 5303
Research output: Contribution to journal › Article › Scientific › peer-review

Controlled wettability of paperboard by nanoparticles using liquid flame spray process

Liquid flame spray process (LFS) was used for depositing TiO_x and SiO_x nanoparticles on paperboard to control wetting properties of the surface. By the LFS process it is possible to create either superhydrophobic or superhydrophilic surfaces. Changes in the wettability are related to structural properties, which were characterized using scanning electron microscope (SEM) and atomic force microscope (AFM). The surface properties can be ascribed as a correlation between wetting properties of the paperboard and the surface texture created by nanoparticles.

General information

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MoE publication type: A4 Article in a conference publication
Organisations: Department of Materials Science, Department of Physics, Abo Akad Univ, Abo Akademi University, Dept Phys, Institute of Paper Converting, Institute of Physics
Contributors: Stepien, M., Saarinen, J. J., Teisala, H., Tuominen, M., Aromaa, M., Kuusipalo, J., Mäkelä, J., Toivakka, M.
Number of pages: 3
Pages: 1390-1392
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ASJC Scopus subject areas: Forestry, Atomic and Molecular Physics, and Optics
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Source: Scopus
Source-ID: 80052429203
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review