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Materials Science and Engineering

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Section Information:

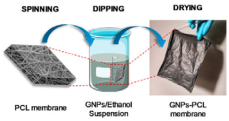
The Section on Materials Science and Engineering encourages multi-disciplinary research in the field of novel material development and innovative material applications. It spans the full range of material types, encompassing polymers, ceramics, metals and hybrid materials. The main focus is on novel developments and applications in society relevant themes. More specifically, articles dealing with the application of materials in novel electronic, optical or mechanical devices, the use of functional materials in applications related to energy and the environment and novel manufacturing techniques, such as additive manufacturing, are highly welcomed. Applied Sciences in general and this Section on Materials Science and Engineering in particular offers a high quality peer review followed by a rapid publication decision.

Featured Papers

DOI:10.3390/app11031124

Smart Fibrous Structures Produced by Electrospinning Using the Combined Effect of PCL/Graphene Nanoplatelets

Authors: Paola Francavilla, Diana P. Ferreira, Joana C. Araújo and Raul Fangueiro

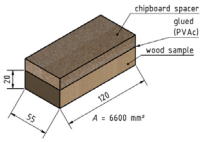


Abstract: Over the years, the development of adaptable monitoring systems to be integrated into soldiers' body gear, making them as comfortable and lightweight as possible (avoiding the use of rigid electronics), has become essential. Electrospun microfibers are a great material for this application due to their excellent properties, especially their flexibility and lightness. Their functionalization with graphene nanoplatelets (GNPs) makes them a fantastic alternative for the development of innovative conductive materials. In this work, electrospun membranes based on polycaprolactone (PCL) were impregnated with different GNPs concentrations in order to create an electrically conductive surface with piezoresistive behavior. All the samples were properly characterized, demonstrating the homogeneous distribution and the GNPs' adsorption onto the membrane's surfaces. Additionally, the electrical performance of the developed systems was studied, including the electrical conductivity, piezoresistive behavior, and Gauge Factor (GF). A maximum electrical conductivity value of 0.079 S/m was obtained for the 2%GNPs-PCL sample. The developed piezoresistive sensor showed high sensitivity to external pressures and excellent durability to repetitive pressing. The best value of GF (3.20) was obtained for the membranes with 0.5% of GNPs. Hence, this work presents the development of a flexible piezoresistive sensor, based on electrospun PCL microfibers and GNPs, utilizing simple methods.

DOI:10.3390/app11062860

Efficiency of Machine Sanding of Wood

Authors: Maciej Sydor, Radosław Mirski, Kinga Stuper-Szablewska and Tomasz Rogoziński

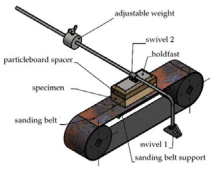


Abstract: We hypothesized that the type of wood, in combination with the grit size of sandpapers, would affect sanding efficiency. Fixed factors were used in the experiment (a belt sander with pressure p = 3828 Pa, and a belt speed of v_s = 14.5 m/s) as well as variable factors (three sand belts (P60, P120, P180), six hardwood species (beech, oak, ash, hornbeam, alder, walnut) and three softwood species (pine, spruce, larch)). The masses of the test samples were measured until they were completely sanded. The sanding efficiency of hardwood species is less variable than for softwood species. Maximum sanding efficiency for the softwood ranged from 1 to 2 min, while for the hardwood species, it ranged from 2 to 4.5 min at the start of sanding and then decreased. The average time for complete sanding of the softwood samples was: 87 s (P60), 150 s (P120), and 188 s (P180). For hardwood, these times were 2.4, 1.5, and 1.8 times longer. The results indicate that the factors determining sanding efficiency are the type of wood, and, secondly, the grit size of sanding belts. In the first phase of blunting with the sanding belts, the sanding processes of hardwood and softwood are significantly different. In the second phase of blunting, sanding belts with higher grit numbers (P120 and P180) behaved similarly while sanding hardwood and softwood.

DOI:10.3390/app11146602

Fine Dust Creation during Hardwood Machine Sanding

Authors: Marta Pędzik, Tomasz Rogoziński, Jerzy Majka, Kinga Stuper-Szablewska, Petar Antov, Lubos Kristak, Richard Kminiak and Martin Kučerka

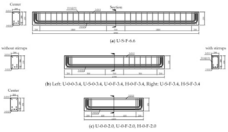


Abstract: Wood dust generated during woodworking—particularly from hardwood species during sanding—poses a health and safety hazard to workers in the wood industry. This study aimed to determine the particle-size distribution of selected hardwood species and the content of fine particles in dust created during machine sanding, which pose the highest health and safety hazards in the woodworking industry. Six hardwood species were studied: black alder, European ash, common walnut, pedunculate oak, hornbeam, and European beech. The sieve analysis method was used to determine the particle-size distribution and article mean arithmetic particle diameter, and laser diffraction analysis was used to determine the finest particle content. Two size ranges were assumed: <2.5 µm and <10 µm. Beech dust had the smallest mean particle diameter. Dust from wood species used in the test had similar contents of fine fractions of particles. The average content of particles smaller than 2.5 µm in wood dust from the tested hardwood species did not exceed 1.9%. In terms of occupational exposure to wood dust, machine sanding conditions of hardwoods should be properly adjusted to limit the formation of large amounts of dust.

DOI:10.3390/app11072951

Evaluation of the Ultimate Strength of the Ultra-High-Performance Fiber-Reinforced Concrete Beams

Authors: Baek-Il Bae, Moon-Sung Lee, Chang-Sik Choi, Hyung-Suk Jung and Hyun-Ki Choi



Abstract: Evaluation of the ultimate strength for the UHPFRC (ultra-high-performance fiber-reinforced concrete) flexural members was conducted. In this study, an experimental program about UHPFRC beams was conducted with the effect of fiber volume fraction, shear span to depth ratio, and compressive strength of matrix as the main variables. Among them, it was found that fiber volume fraction was the variable that had the greatest influence on the ultimate strength. The inclusion of 2% volume fraction steel fiber increases the shear and flexural strength of UHPFRC beams significantly. In particular, steel fiber inclusion changed the mode of failure of beams from diagonal shear failure into flexural failure. For the classification of failure patterns, the ultimate flexural strength and shear strength of UHPFRC members were evaluated using the current design code and UHPC guidelines. Flexural ultimate strength was affected by the size and shape of the stress block and consideration of the matrix's tensile strength. For the accurate shear strength prediction of UHPFRC beams, the tensile strength of the high strength matrix and the effect of steel fiber should be considered.

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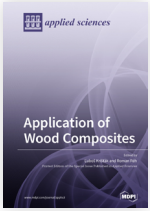

Recent Advances in Theoretical and Computational Modeling of Composite Materials and Structures

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