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Nanocellulose for functional surface modification and coatings

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Cellulose is the most abundant, renewable, biodegradable and environmentally friendly organic compound found in nature. Cellulose is found in wood, plant fibers, marine animals, algae, fungi, and bacteria. Nanocellulose material is composed of fibrils with high aspect ratio (length to width ratio). These fibrils have lengths and widths in the micrometer and nanometer scales. Nanocellulose solutions or gels can be employed to fixate dye, antimicrobial, flame retardant, stain and soil resistant, hydrophilic, and/or other molecules to polyester, acrylic, polypropylene, nylon, cotton, and other types of fabrics. The first part of this research is to chemically modify nanocellulose gels with Polyethylenimine (PEI) and Poly(Oligoethylene Glycol Methacrylate) (POEGMA) to improve the adhesion between nanocellulose fibers and textile fabrics, and make stable, smooth, thin films for coating of textile materials. The second part of this research is to develop a new dyeing process using nanocellulose gels to reduce consumption of water and energy. The conventional dyeing process requires huge amounts of water and, produces large volumes of waste water. The dyeing technique using nanocellulose gels eliminates the need for enormous amounts of water and substantially decreases the amount of waste water.

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Three dimensional graphene sponge for use as a highly efficient and recyclable absorbent for oil water separation

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Three-dimensional graphene sponges obtained by enhanced Hummer's method and freeze-drying are a highly efficient tool for use during oil-water separation1. Due to the hydrophobic nature of the graphene and contact angles with water in excess of 170, three dimensional graphene sponge is an invaluable and feasible substitute to various natural absorbers and organic materials such as expandable perlite and wool fibre2. Due to the high porosity of the spongy graphene, it can absorb oils from 50 times up to a maximum of 120 times its own weight in various oils. For this study, a shape-mouldable and three dimensional spongy graphene with high specific surface area used as a protean and recyclable sorbent for not only oils but also toxic solvents such as chloroform. The nanoporous characteristic allows spectroscopy and microscopic studies such as the use of Raman spectroscopy and Environmental Scanning Electron Microscopy (ESEM). We study the influence of various parameters (porosity, hydrophobicity, surface area) on the absorption capability of the graphene sponge. Furthermore, we also report how to improve the regeneration efficiency(> 12 times) by heat treatment, adhering to the full release of absorbates (>99%) and still exhibiting the same micro and macro structure as before. In addition we will discuss how the introduction of halogen atoms to the graphene sponge enhances superhydrohobicity. The present work demonstrates that graphene sponges can be used in industry to separate oils and water. Topics regarding environmental protection will also be addressed.

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