Manish Singh et al., J Nanomater Mol Nanotechnol 2018, Volume 7
DOI: 10.4172/2324-8777-C1-020

23rd International Conference on
Nanomaterials and Nanotechnology
March 15-16, 2018 | London, UK

Selective processings with pyrrole and KMnO4 help build multi-functional Polypyrrole-MnO2 silks: application to sensing

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In the silk industry, a large fraction of raw or waste silk is left underexploited. These natural fibers offer untapped hierarchical structures organization, to template the formation of functional groups. Accessing the part of these organized structures has been a major challenge. In this work we demonstrate that selective impregnation using supercritical carbon dioxide ($scCO_2$) and sonication of *Bombyx mori* (commercial silkworm) silk fibers could impart multi functionality.

In a first step, $scCO_2$ was used to impregnate pyrrole monomers into *Bombyx mori* silks fibers, followed by iron chloride oxidative polymerization at atmospheric pressure and 4˚C. Under supercritical condition, fiber swelling and pyrrole increased solubility drove pyrrole enrichment in the fibers by diffusion. Upon return to atmospheric conditions, the fibers contracted back with the pyrrole monomer organized and ready for an oxidative polymerization. The resulting $scCO_2$ treated fibers had six times higher conductivity for a lower mass increase in polypyrrole, compared to fibers treated and polymerized at atmospheric conditions. This suggested a more linear and homogeneous polymer arrangement for the $scCO_2$ treated fibers. In a second step, sonication was used for the synthesis and impregnation of metal oxide nanoparticles (MnO_2) onto the afore mentioned Ppy-silk fiber. The functionality of Ppy-MnO_2-silk fiber was tested using methylene blue (spectrophotometrically) and hydrogen peroxide degradation (electrochemically).

The result showed higher rate of MB degradation for $scCO_2$ prepared Ppy-MnO2-silk fiber compared with control approached prepared Ppy-MnO_2-silk fiber. The degradation of hydrogen peroxide using cyclic voltammetry showed that Ppy-MnO_2 silk fiber could be used directly as a soft electrode for sensing H_2O_2.

In conclusion, we demonstrated that the combination of $scCO_2$ impregnation and sonochemistry could yield new or improved multifunctionality. We therefore argue, given the structural and chemical variations found in natural polymers, that similar results could be generic.

Biography

Manish Singh is pursuing his PhD from Lund University, Sweden. He has completed his master degree in Material chemistry at Stockholm University. He did bachelors in Ceramic Engineering from Indian Institute Of Technology-Banaras Hindu University (IIT-BHU) Varanasi, one of the premier institutes of India which offers technical education.

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