Bio-based nanomaterials for diversified applications

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This study demonstrates the preparation of chitin nanofibers from shrimp and crab wastes using different mechanical treatments such as high speed blender and ultrasonic homogenizer. FE-SEM image and microscopic image showed that uniform fibrillated nanofibers having diameter of 30-50 nm can be obtained. The obtained chitin nanofibers were small enough to retain the transparency of the neat acrylic resin. Chitin acrylic resin films exhibited much higher transparency than cellulose acrylic resin films. The incorporation of chitin nanofibers contributes to the significant improvement of the thermal expansion and mechanical properties of the neat acrylic resin. Furthermore, by reinforcing chitin powder with acrylic resin, optically transparent composites were developed since particles substantially larger than the optical wavelength do not cause light scattering if the particles are composed of nano-elements such as nanofibers and have nanoporous space so that matrix resin impregnation is possible. Encouraged by these findings, we developed low thermally expanded transparent film by exploiting wood fibers that can be considered to be nanostructured fibers in which individual nanofibers do not significantly agglomerate and are orientated parallel to the fiber direction in S2 layer which accounts for 70-80% of wood fibers. In addition, three dimensional moldable optically transparent nanocomposites with low thermal expansion through emulsification process were developed. Emulsions of chitin nanofibers and acrylic resin are stabilized by the hydrophilic and high-specific-surface-area chitin nanofiber networks preventing the coalescence of tiny emulsion resin droplets. The properties of high light transmittance and low thermal expansion make chitin nanocomposites promising candidates for the substrate in a continuous roll-to-roll process in the manufacturing of various optoelectronic devices such as flat panel displays, bendable displays, and solar cells. We are presently working on deacetylated chitin nanofibers film which are embedded by chitosan and could be suitable for bio-medical applications.

Recent Publications:

S.K Biswas, H. Sano, **M. I. Shams,** H. Yano (2017) Three-dimensional-moldable nanofiber-reinforced transparent composites with a hierarchically self-assembled "reverse" nacre-like architecture, ACS Applied Materials & Interfaces 9 (35) 30177-30184

M.I. Shams and H. Yano (2015) Doubly curved nanofiber-reinforced optically transparent composites, Scientific Reports (Nature Publication Group) 5, 16421

H Yano, S Sasaki, **M.I. Shams**, K Abe and T Date (2014) Wood pulp based optically transparent film: A Paradigm from nanofibers to nanostructured fibers, Advanced Optical Materials 2 (3), 231-234

M.I. Shams and H. Yano (2013) Simplified fabrication of optically transparent composites reinforced with nanostructured chitin. J Polym Environ 21, 937-943

M.I. Shams, M. Nogi, L. Berglund, H. Yano (2012) The transparent crab: preparation and nanostructural implications for bioinspired optically transparent nanocomposites, Soft Matter 8:1369-1373

Biography:

Dr. Shams completed his MS and Ph.D in Wood Science and Technology from Kyoto University, Japan under Japanese Government Monbukagakushu scholarship. From 2008-2010 he worked as JSPS Postdoctoral fellow and later 2012-14 working as visiting scientist in Kyoto University, Japan. He was also working as an invited visiting scientist in Royal Institute of Technology Sweden, Nanjing Forestry University, China and Kyoto University Japan. Dr. Shams holds two patents and published more than 35 journal articles. For greater contribution in the field of forest and agricultural science in Bangladesh, he was awarded 'UGC AWARD 2015' from University Grants Commission of Bangladesh. His research involves production of biocomposites and extraction of nanofibers from biomass resources and their utilization for optical and structural purposes. He also handled a good number of funded projects including World Bank sponsored, Japan Society for the Promotion of Science (JSPS), The World Academy of Sciences (TWAS) and so on. He is now working as a professor of Forestry and Wood Technology Discipline, Khulna University, Bangladesh.

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