# Engineering at the Nanoscale: A Strategy for Developing High Performance Functional Materials from Biopolymers

SABU THOMAS

Vice Chancellor, Mahatma Gandhi University, Priyadarshini Hills P. O.

Kottayam, Kerala, India -686 560

### Abstract

Green chemistry started for the search of benign methods for the development of nanoparticles from nature and their use in the field of antibacterial, antioxidant, and antitumor applications. Bio wastes are eco-friendly starting materials to produce typical nanoparticles with well-defined chemical composition, size, and morphology. Cellulose, starch, chitin and chitosan are the most abundant biopolymers around the world. Cellulose nanoparticles (fibers, crystals and whiskers) can be extracted from agrowaste resources. Chitin is the second most abundant biopolymer after cellulose, it is a characteristic component of the cell walls of fungi, the exoskeletons of arthropods and nanoparticles of chitin (fibers, whiskers) can be extracted from shrimp and crab shells. Starch nano particles can be extracted from tapioca and potato wastes. These nanoparticles can be converted into smart and functional biomaterials by functionalization through chemical modifications due to presence of large amount of hydroxyl group on the surface. The preparation of these nanoparticles includes both series of chemical as well as mechanical treatments; crushing, grinding, alkali, bleaching and acid treatments. Since large quantities of bio wastes are produced annually, further utilization of cellulose, starch and chitins as functionalized materials is very much desired. The cellulose, starch and chitin nano particles are currently obtained as aqueous suspensions which are used as reinforcing additives for high performance environment-friendly biodegradable polymer materials. These nanocomposites are being used as biomedical composites for drug/gene delivery, nano scaffolds in tissue engineering and cosmetic orthodontics. The reinforcing effect of these nanoparticles results from the formation of a percolating network based on hydrogen bonding forces. The incorporation of these nano particles in several bio-based polymers have been discussed. The role of nano particle dispersion, distribution, interfacial adhesion and orientation on the properties of the ecofriendly bio nanocomposites have been carefully evaluated.

**Recent Publications**

1. Patanair, B., Saiter-Fourcin, A., Thomas, S., Thomas, M. G., Parathukkamparambil Pundarikashan, P., Gopalan Nair, K., ... & Delpouve, N. (2021). Promoting interfacial interactions with the addition of lignin in poly (lactic acid) hybrid nanocomposites. Polymers, 13(2), 272.
2. Jose, C., Chan, C. H., Winie, T., Joseph, B., Tharayil, A., Maria, H. J., ... & Thomas, S. (2021). Thermomechanical Analysis of Isora Nanofibril Incorporated Polyethylene Nanocomposites. Polymers, 13(2), 299.
3. Amalraj, A., Raj, K. J., Haponiuk, J. T., Thomas, S., & Gopi, S. (2020). Preparation, characterization, and antimicrobial activity of chitosan/gum arabic/polyethylene glycol composite films incorporated with black pepper essential oil and ginger essential oil as potential packaging and wound dressing materials. Advanced Composites and Hybrid Materials, 3(4), 485-497.
4. Varghese, R. J., Parani, S., Adeyemi, O. O., Remya, V. R., Maluleke, R., Thomas, S., & Oluwafemi, O. S. (2020). Green Synthesis of Sodium Alginate Capped-CuInS 2 Quantum Dots with Improved Fluorescence Properties. Journal of Fluorescence, 30(6), 1331-1335.

5. Nourbakhsh, M., Zarrintaj, P., Jafari, S. H., Hosseini, S. M., Aliakbari, S., Pourbadie, H. G., ... & Saeb, M. R. (2020). Fabricating an electroactive injectable hydrogel based on pluronic-chitosan/aniline-pentamer containing angiogenic factor for functional repair of the hippocampus ischemia rat model. Materials Science and Engineering: C, 117, 111328.

 Biography

Sabu Thomas is currently the Vice-Chancellor of Mahatma Gandhi University, Kottayam, Kerala, India. He is a Professor at the International and Inter University Centre for Nanoscience and Nanotechnology and Full Professor of Polymer Science and Engineering at the School of Chemical Sciences of Mahatma Gandhi University, Kottayam, Kerala, India. His ground-breaking research has covered the areas of polymer science and engineering, polymer nanocomposites, elastomers, polymer blends, interpenetrating polymer networks, polymer membranes, green composites and nanocomposites, nanomedicine and green nanotechnology. Prof. Thomas has received several national and international awards in recognition for his work, and recently received Honoris Causa (DSc) from the University of South Brittany, Lorient, France, in recognition for his contributions to polymer science and engineering. Prof. Thomas has published over 1400 peer- reviewed research papers, reviews and book chapters. He has co-edited more than 210 books. Currently he is having a H index of 137 with 90000 citations.

Email: sabuthomas@mgu.ac.in