A Breakthrough in toxic dye and nanoparticle removal from water using cellulose based Nano filters from Agrowaste

A Nanocellulose based nanofibrous membrane from agro waste(Pineapple, Banana, coir etc) for the removal of toxic textile dyes and nanoparticles from water has been developed by the IIUCNN, Mahatma Gandhi University, Kottayam under the supervision of Sabu Thomas and Dr. Nandakumar Kalarikkal and Federal University of Uberlandia, Brazil under the supervision of Prof. Daniel Pasiquini. The results of the study were recently published in ACS Sustainable Chemistry and Engineering. They developed a facile method to produce a unique green adsorbent material from cellulose nanofibers (CNFs) from agrowaste via a non-solvent assisted procedure using Meldrum's acid as an esterification agent to enhance the adsorption towards positively charged textile toxic dyes. Nanofibrous membrane was developed via successive coating of the Meldrum's acid modified cellulose nanofibers over the PVDF electrospun membrane.

"The Meldrum's acid modified CNF-based PVDF membrane showed very good adsorption capacity towards dyes, because of the high electrostatic attraction between the positively charged dyes and carboxylate groups (negatively charged) on the surface of Meldrum's acid modified CNFs on PVDF electrospun membrane. The demonstrated membrane was successfully filtered out the nanoparticles from water" **Said Prof. Thomas**

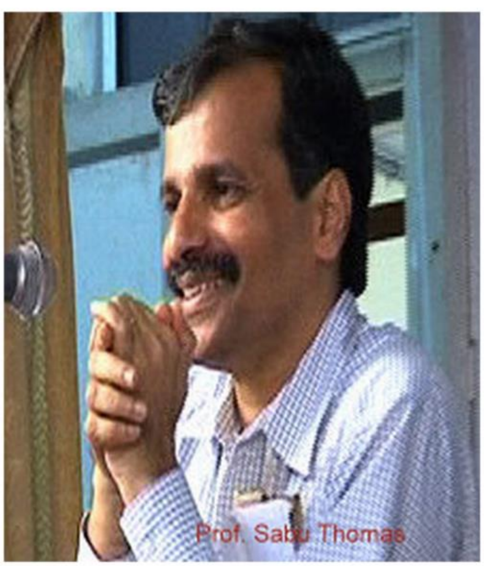
Nanomaterials play a significant role in developing new materials with high efficiency at low cost for water pollution. Among the nanomaterials, cellulose nanofibers (CNFs) are one of the promising adsorbent materials for water purification due to their low cost, abundant hydroxyl groups, natural abundance, and ecofriendly nature. Moreover, "the CNFs have the enormous amount of surface hydroxyl (OH) groups, which enables a lot of surface chemistries or incorporation of chemical groups that may increase the adsorption toward the various pollutants in water" **Said Dr. Nandakumar Kalarikkal**

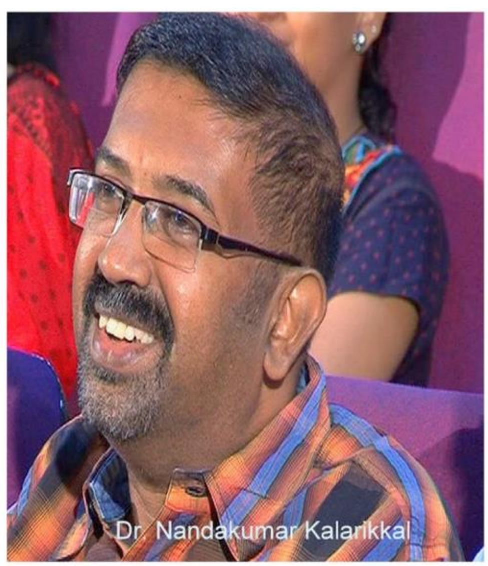
Most of the surface modifications of cellulose nanofibers have been done using toxic organic solvents. So far, this is the first report on the surface modifications of cellulose nanofibers via non solvent assisted procedure. Electrospun membranes have some advantages over the membranes produced via phase immersion methods such as higher effective porosity with continuously interconnected pores, light weight, and high surface area. Therefore, “electrospinning is a promising technique for generating continuous fibers with diameters in the range of a few hundred nanometers. They exhibit excellent mechanical strength, water flux, and particle rejection. These properties make electrospun membranes an excellent platform for microfiltration applications” **Said Prof. Thomas**

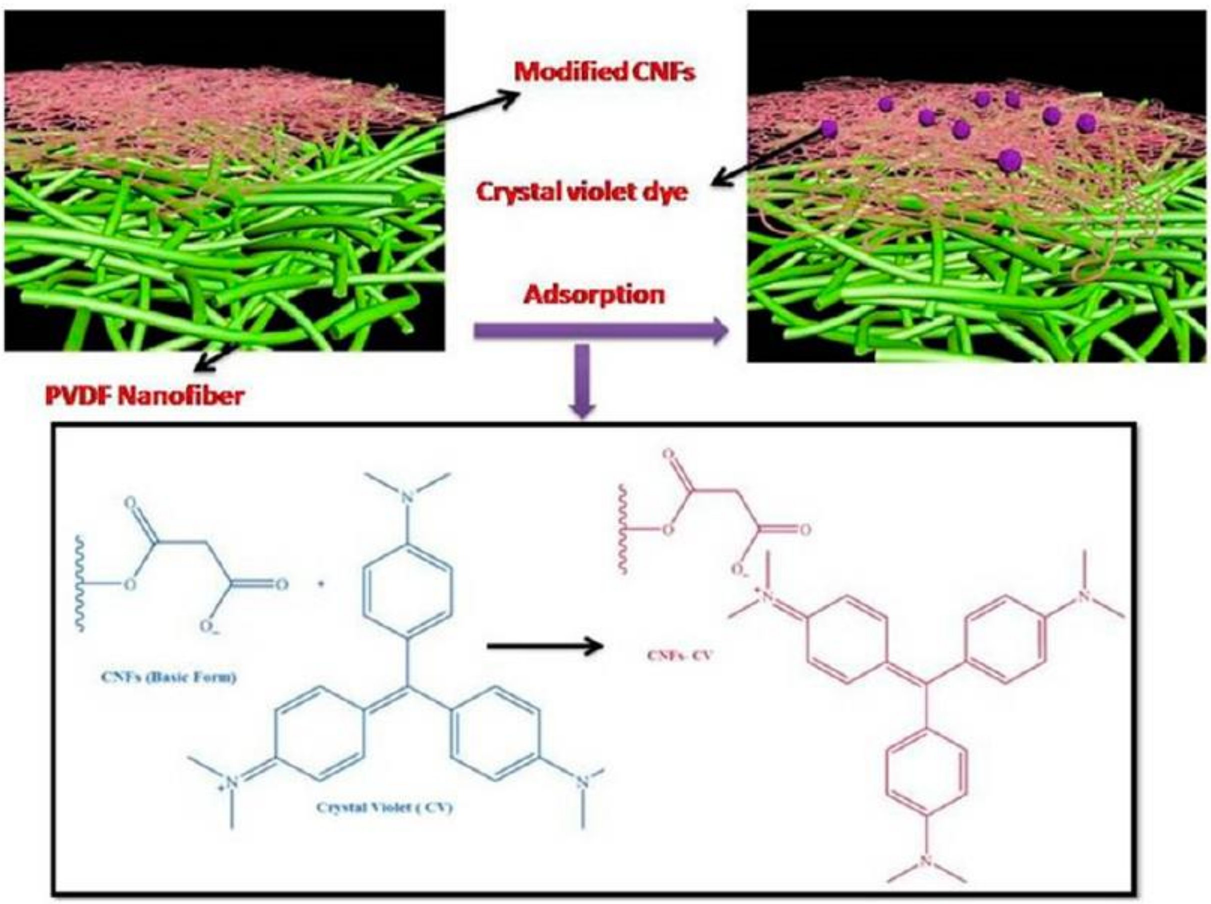
However, the average porosity of the electro spun membrane is too high to remove smaller objects like textile dyes by size exclusion. So, to eliminate the minute particles like textile dyes, an additional adsorption mechanism is essential without affecting the permeability of electrospun MF membranes. One of the typical approaches to remove dyes from wastewater is to increase the electrostatic charges of the MF membrane to enhance the absorption capability

This novel membrane can be successfully used to remove the toxic textile dyes and nanoparticles (with rejection of over 99%) from water. “This demonstrated membrane is unique as it can concurrently eliminate toxic textile dyes and nano-particles from water. So it is auspicious for use in water treatment applications”. **Said Prof. Thomas**

“All the experimental results suggested that the Meldrum’s-modified CNFs were a promising additive for modifying the MF membrane. Moreover, this study opens up a new platform for the surface modifications of cellulose nanofibers solvent-free techniques, which can enhance the economic feasibility of the process” **Said Dr. Nandakumar Kalarikkal**.







Schematic Representation of crystal violet dye removal by Meldrum's acid- modified CNF-based PVDF nanofibrous membrane and its mechanism.