A green Hybrid Aerogel Nanocomposite from Dendritic Colloidal Silica and Hairy Nanocellulose as an Effective Dye Adsorbent

Marzieh Heidari Nia, Saskatchewan university; Lee D. Wilson, Supervisor, lee.wilson@usask.ca , Department of Chemistry, University of Saskatchewan, 110 Science Place, Saskatoon, SK, S7N 5C9, Canada

In the past few decades, human activities and the rapid growth of industries and has caused severe damage to the environment and the ecosystem of the Earth. Pollution in water due to industrial, urban, and pharmaceutical wastewater concerns scientists.
Dyes have been widely used in many industries, such as textile, printing, leather, paper, plastics, and cosmetics. Synthetic dyes with complex structures and a highly toxic nature have harmful impacts, including teratogenic, mutagenic, or carcinogenic influences on aquatic life and human health. The elimination process from contaminated water is very challenging due to its high solubility in water. Therefore, it is crucial to eliminate dyes before discharging industrial effluents into the environment. Herein, a new type of silica-cellulose hybrid aerogel was synthesized through a green and facile chemical cross-linking process. In the first step, dendritic fibrous nanostructured (colloidal) silica particles (DFNS) were prepared by a simple hydrothermal technique. Then, the surface of DFNS particles was functionalized with amine groups using 3-aminopropyltriethoxysilane (APTES) to produce DFNS-NH2. In the second step, bifunctional hairy nanocellulose (BHNC) particles were produced with both aldehyde and carboxylic groups. The aldehyde groups of BHNC and the amine groups of DFNS-NH2 chemically reacted through a dynamic Schiff base reaction to form a hybrid hydrogel nanocomposite. Therefore, no external cross-linker is required in the synthesis. This hybrid aerogel is very lightweight and highly porous, with a density of 0.107 g mL–1 and a porosity of 93.0 ± 0.4%. It has a large surface area of 350 m2 g–1, a large pore volume of 0.23 cm3 g–1, and a small pore size of 3.9 nm. The developed green aerogel contains both positively and negatively charged functional groups and is a highly efficient substrate for the absorption of both cationic and anionic organic dyes. These aerogels were developed to have a remarkable adsorption capacity toward methylene blue (MB) as a cationic dye and methyl orange (MO) as an anionic dye. The results show that the aerogels can adsorb MB and MO with a capacity of 270 and 300 mg dye/g adsorbent, respectively, which is outstanding among other absorbents.