ABSTRACT

Concerns about anthropogenic climate change and rising pollution have prompted scientists to seek greener, more sustainable materials. In light of its sustainability and abundance, cellulose has the potential to be a solution. Cellulose nanofibers (CNF) are used in a variety of industries, including construction, automobiles, paper coating, flexible displays, electronic sensors, biomedicine, and targeted drug delivery, due to their appealing properties such as a large number of functional groups on the surface, high mechanical strength, and excellent optical properties. Despite the fact that CNF is considered green and sustainable, the cellulose extraction method and subsequent nanofibrillation processes are not green and sustainable due to the extensive use of toxic chemicals and energy-intensive processes. This study aims to establish sodium carbonate as a sustainable pre-treatment technique for the extraction of cellulose microfibers. These extracted microfibers are nanofibrillated through three distinct processes to yield CNF. The nanofibers are used in three different structural configurations: thin films, thermoset epoxy composites, and aerogels. In thin film structures, we have targeted three distinct applications: UV shielding, EMI shielding, and high dielectric strength film composites. For aerogel preparation, we used uncomplicated and environmentally friendly methods such as ambient drying, freezing in a household refrigerator, and the biodegradable polymer polycaprolactone to impart surface hydrophobicity to the CNF foams. These composites possess environmentally sustainable characteristics, as they do not contain any additional toxic chemicals for surface modification or binding agents. Furthermore, they exhibit notable efficacy in their respective applications.