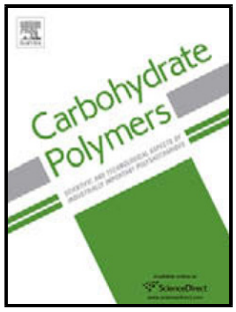

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Adsorption and desorption of cationic malachite green dye on cellulose nanofibril aerogels

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Highlights

- Hierarchical macro- and meso-porous cellulose nanofibril aerogels with high specific surface and anionic surface charge have shown to high adsorption capacity of 212.7 mg/g toward cationic dyes in pseudo-second-order kinetic and with aLangmuir adsorption isotherm. The excellent wet resilient aerogels could remove 100% dye in four repetitions or adsorb over 92% dye in single batch adsorption as well as be regenerated in media with increased ionic strength.

ABSTRACT

Ultra-light aerogels have been assembled from cellulose nanofibrils into hierarchically macroporous (several hundred μm) honeycomb cellular structure surrounded with mesoporous (8-60 nm) thin walls. The high specific surface (193 m^2/g) and surface carboxyl content (1.29 mmol/g) of these aerogels were demonstrated to be highly capable of removing cationic malachite green (MG) dye from aqueous media. The rapid MG adsorption was driven by electrostatic interactions and followed a pseudo-second-order adsorption kinetic and monolayer Langmuir adsorption isotherm. At a low 1:5 mg/mL aerogel/MG ratio, both initial MG adsorption rate (2.3 to 59.8 $mg \cdot g^{-1} \cdot min^{-1}$) and equilibrium adsorption capacity (53.0 to 203.7 $mg \cdot g^{-1}$) increased with increasing initial MG concentrations from 10 to 200 mg/L, reaching a maximum adsorption of 212.7 $mg \cdot g^{-1}$. The excellent dye removal efficiency was demonstrated by complete MG removal through four repetitive adsorptions at a low 1:5 mg/mL aerogel/MG ratio and 10 mg/L dye concentration as well as 92 % MG adsorption in a single batch at 10:5 mg/mL aerogel/MG ratio and 100 mg/L dye concentration. The adsorbed MG in aerogels could be desorbed in aqueous media by increasing ionic strength, demonstrating facile dye recovery as well as the robust capability of this aerogel for repetitive applications.

Keywords: Aerogel, cellulose nanofibrils, cationic dye, malachite green, adsorption, desorption