

Supplementary information

Synthesis of bagasse-derived carboxymethyl cellulose aerogels for efficient removal of cationic dyes and heavy metal ions

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X-ray diffraction analysis

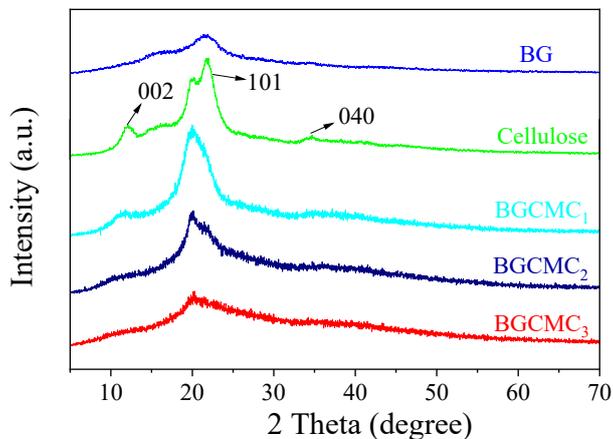


Fig. S1. XRD curves of BG, cellulose, and BGCMC₁₋₃.

In cellulose extracted from BG, the increased crystallinity is due to the removal of lignin and hemicellulose with amorphous regions, resulting in altered hydrogen bonding between the cellulose chains,¹ and the rearrangement of cellulose molecules. Fig. S1 shows the XRD pattern of the as-prepared polymeric material. The three diffraction peaks at 12.5, 21.9, and 34.6° correspond to the (002), (101), and (040) crystallographic planes of cellulose I, respectively.² Disappearance of the (002) and (040) crystalline planes is observed in BGCMC in Fig. S1. The intensity of the diffraction peak of the (101) crystalline plane gradually decreases with increasing DS, owing to the alkali treatment during the etherification of cellulose. Alkali treatment promotes the expansion of the crystalline region and partial breakage of hydrogen bonds, leading to decreased crystallinity. The access of carboxymethyl into the cellulose after etherification leads to a structural transformation from cellulose I to cellulose II.³

Thermogravimetric analysis

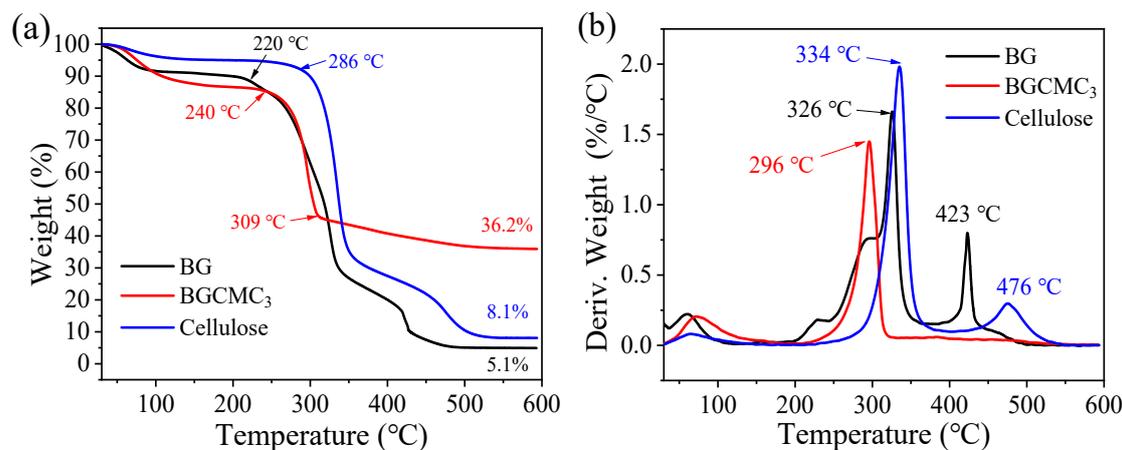


Fig. S2. (a) TGA curves of BG, BGCMC₃, and cellulose; (b) DTG curves of BG, BGCMC₃, and cellulose

The thermal stability of BGCMC₃ was investigated using thermogravimetric analysis (TGA), as shown in Fig. S2a and S2b. The total weight losses of BG, cellulose, and BGCMC₃ were 94.9%, 91.9%, and 63.8%, respectively. The pyrolysis process consisted of three decomposition stages: dry water loss, rapid thermolysis, and carbonisation. The thermal decomposition behaviour of BGCMC₃ was analysed according to the change in weight percentage. In the first stage, the water weight loss was approximately 14.41% below 120 °C owing to the pyrolysis of physically adsorbed water.⁴ The major mass loss (39.49%) in the range of 200–309 °C was associated with the decomposition of oxygen-containing groups, including hydroxyl and carboxyl.⁵ The final stage of the process generated ash and fixed carbon with a weight loss of 8.50%. Cellulose underwent the second stage only at 286 °C, probably because hemicellulose increases the pyrolysis temperature.⁶ The differential thermogravimetry (DTG) curve analysis (Fig. S2b) more clearly shows the difference

in thermal behaviour between BG, cellulose, and BGCMC₃, with peaks at 423 and 476 °C. This may be caused by the carbonisation of the highly cross-linked polymer network of BG and cellulose, which requires more energy to disrupt (300 < T < 500 °C).⁷ According to the DTG results, the maximum degradation temperatures of BGCMC₃, BG, and cellulose are at about 296, 326, and 336 °C, respectively. This indicates that BGCMC₃ exhibits a lower thermal stability than BG and cellulose, probably due to the large number of carboxyl groups leading to structural changes.⁸

References

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