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Structural characteristics of biochar-graphene nanosheet composites and their adsorption performance for phthalic acid esters

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The nonuniform and unhomogenous structure of biochar including defects could affect the adsorption performance of biochars. Biochar and graphene nanosheet (GNS) composites (BG) were prepared by simple dip coating method following thermal route of bamboo wood biomass at three different temperatures (300, 500, 700°C), in addition to biochars. The morphology and structural composition of biochars and BG composites were examined by scanning electron microscopy, transmission electron microscopy, Brunauer-Emmet-Teller surface area with N2 and CO_2, Raman spectroscopy, Fourier Transformed Infrared spectroscopy, X–ray Photoelectron spectroscopy, Thermogravimetric analysis and CHN elemental analysis. It was found that GNS ($\sim 1\mu$m, 0.1% mass) provided higher thermal stability, porous structure, and relatively higher surface area (N2 and CO_2), to BG composites. BG composites portrayed the existence of GNS bearing cavities and evidently increased the graphitic structure. The adsorption capabilities of biochars and BG composites towards dimethyl phthalate (DMP), diethyl phthalate (DEP), and dibutyl phthalate (DBP) as model phthalic acid esters (PAEs) were examined by batch sorption technique. The BG composites exhibited the increased adsorption capacity comparatively to biochars. The aromatic sheets of biochars and GNS on biochars dominated the π–π EDA (electron donor–acceptor) interaction for ring structure of DMP molecule in addition to pore-diffusion mechanism, whereas adsorption of DBP was attributed to hydrophobicity. Our results suggest that surface composition and morphology of biochars can be regulated with GNS and may enhance their adsorption capacity, thus could be considered for effective environmental remediation of various organic contaminants.