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Synthesis and performance evaluation of Mg/Ce/Mn trimetal oxide-modified diatomaceous earth in groundwater defluoridation

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Groundwater accounts for 25 to 40% of the world's drinking water. It is the most preferred alternative source of drinking water for rural communities in the absence of pipe-borne water, being less prone to microbial contamination compared to surface water. However, groundwater as drinking water is known to cause dental and skeletal fluorosis in human if its fluoride content is above the WHO guideline of 1.5 mg/L in drinking water. It is therefore pertinent to reduce the fluoride in groundwater to an acceptable level (0.5-1.5 mg/L) necessary for the development of healthy teeth. In this study, Mg/Ce/Mn oxide-modified diatomaceous earth (DE) was produced by co-precipitation of the metal hydroxides on DE, characterized and applied in batch defluoridation of fluoride spiked water. The sorbent displayed high fluoride removal potentials (> 93% fluoride removal) for solutions with initial fluoride concentration of 10 mg/L - 60 mg/L at sorbent dosage of 0.6 g/100 mL (contact time: 60 min, mixing speed of 200 rpm and temperature: 297 K). The optimum fluoride uptake capacity was 12.63 mg/g for a solution containing initially 100 mg/L fluoride. Percent fluoride removal was above 91% for fluoride solutions with initial concentration of 9 mg/L, over a pH range of ~ 4 to 11, sorbent dosage being 0.6 g/100 mL. The equilibrium pH was greater than the sorbent's pHPzc of 5.45. Fluoride removal was therefore by exchange of surface hydroxyl groups by fluoride ions. Sorption data fitted better to Langmuir isotherm and pseudo-second-order model. External diffusion was observed to be the sorption rate limiting step.

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Stiffening mechanisms in vermiculite-amorphous polyamide bio-nanocomposites

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Sub-micron thick flakes were obtained by sonication of vermiculite that was first exfoliated by either thermal shock or chemical treatment with hydrogen peroxide. Dimer fatty acid polyamide nanocomposites with a mixed morphology were prepared via a solution-dispersion technique. The large (in the micrometre range) vermiculite flakes assumed random orientations in the matrix. BET surface area measurements indicated flake thickness below 100 nm but SEM showed that thicker flakes were also present. Filler content was varied up to 30 wt.%. At this loading, the tensile strength doubled, the modulus increased five-fold but the elongation-at-break decreased by a factor of ten. Dynamic mechanical analysis suggests three stiffening mechanisms. The reinforcing effect of the high stiffness inorganic flakes is the primary contributor. Together with the chain confinement effect, that expresses itself in an apparent increase in the glass transition temperature, provides an adequate rationalisation of the stiffness variation below T_g . However, an additional stiffening effect is indicated at temperatures above T_g . The mechanism may involve dynamic network formation based on fluctuating hydrogen bonding interactions between the matrix polymer chains and the filler particles.

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