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Carbon Nanotubes@graphene Oxide Hybrid Hydrosols Sealed in Dialysis Dag for Trace Gd(III) Removal from Water and their Synergistic Enhancement Effect

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Graphene oxide(GO) is an efficient two-dimensional (2D) adsorbent for remediation of trace rare earth ions wastewater, however its major disadvantage of layer stacking in adsorption process has greatly restricted bringing into full play its inherent adsorption ability. Hence we propose the introduction of one-dimensional(1D) carbon nanotubes (CNTs) into 2D GO hydrosol sealed in dialysis bags to form CNTs@GO hybrid hydrosol by ultrasonication for adsorptive removal of rare earth ions. In this work, the effects of pH value, contact time and temperature on Gd(III) adsorption of CNTs@GO hybrid hydrosol were also systematically investigated. The results show that the theoretical maximum adsorption capacity of CNTs@GO hybrid hydrosol with the weight ratio of CNT: GO=1:6 for Gd(III) was observed to soar from 286.86 mg g-1of GO to 534.76 mg g-1 (pH=5.9, t=60min, T=303K), giving a sufficient evidence that the layer stacking of GO nanosheets in the adsorptive process of Gd(III) could be reduced to a large extent with the introduction of CNTs and presenting the remarkable synergistic enhancement effect. The kinetics and thermodynamics analysis reveals that the adsorption of Gd(III) on CNTs@GO hybrid hydrosol was in agreement with the Pseudo-second-order model and Langmuir isotherm adsorption models. CNTs@GO hybrid hydrosol for Gd(III) removal can achieve adsorption equilibrium within 60 min, and can also maintain the adsorption capacity of 347.84mg g-1 after four adsorption-desorption cycles and the desorption rate of 80.03 % at the 5th cycle. In prospect, CNTs@GO hybrid hydrosol sealed in dialysis bags offers great promise for treatment of wastewater containing trace other rare earth or heavy metal ions with dramatically enhanced absorption performance and no second pollution.