CARBON 2019

Short Abstract

Phosphorous Doped Nanoporous Carbons for Adsorption of Rare Earth Elements

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Preferred presentation: **Oral**

Rare earth elements (REE) are highly priced elements that have extensive applications in various energy sectors, national security and military appliances. Majority of the REEs are imported from foreign countries and recent export restrictions from those countries has led the researches to seek an indigenous and sustainable way to meet their demands. Neodymium (Nd) and Dysprosium (Dy) are two of those highly valued rare earth elements and one of the possible ways to maintain a constant supply is to recover them from waste permanent magnets. As REEs have affinity towards phosphorus functionalities on the sorbent surface, in this work, phosphorous-doped nanocarbons were synthesized with BET surface area of 837 m^2/g and 0.9 atom% phosphorus. Neodymium and dysprosium adsorption in this carbon was in the range of 335–344 mg/g in water and such adsorption amount is higher than that of majority of the adsorbents reported in literature. The adsorption capacity of iron (Fe(III)) under the similar conditions was one order of magnitude lower suggesting a possible separation of these rare earth elements from iron present in the waste magnets. XPS studies on both Nd and Dy-adsorbed carbons revealed a higher shift in the P-$2p_{3/2}$ energy level suggesting a possible formation of metallic phosphates. Furthermore, XPS also revealed a small amount of carbonates and oxides of rare earth elements that might have been formed on the surface of adsorbents. The overall results suggest that this carbon can be used as a potential sorbent for enrichment and separation of Nd and Dy.