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Postgraduate Institute of Science (PGIS) University of Peradeniya - Sri Lanka
23rd & 24th August 2024

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POSTGRADUATE INSTITUTE OF SCIENCE (PGIS)
UNIVERSITY OF PERADENIYA, SRI LANKA



PR04

X-RAY PHOTOELECTRON SPECTROSCOPIC ANALYSIS OF GRAPHITE OXIDE-COATED SAND FOR FLUORIDE REMOVAL

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Excess fluoride in drinking water can risk human dental and skeletal health. Several methods exist to remove the excess fluoride; however, the development of a sand filter unit is a more cost-effective and valuable option. This research used an improved synthesis of graphite oxide (GO) to enhance the reactivity of natural sand. The GO dispersion was coated on the sand surface using mild heat treatment of the sand composite labeled as GOS1. The GO coating procedure on sand was repeated up to three times (GOS3) and five times (GOS5). X-ray photoelectron spectroscopic (XPS) measurements were recorded with AlK_α X-ray source (1486.7 eV, 180° hemispherical energy analyzer with a radius of 150 mm). The XPS measurements elucidated the surface functional groups of GO, sand, and GO/sand composites. The C 1s spectrum of GO can be deconvoluted into peaks at the binding energies (BE) of 288.5 eV, 287.9 eV, 286.9 eV, 286.7 eV, 284.9 eV and 283.4 eV, attributed to carboxylic (COOH), carbonyl (C=O), epoxy (C-O-C), hydroxyl (C-OH), C sp² (C=C) and C sp³ (C-C), respectively, using the Gaussian function. Compared to GO, three different peaks were observed in the BE range of 283.8-283.9 eV, 285.3-285.4 eV and 289.4-289.8 eV, corresponding to the C-Si, C-O-Si and π-π* transition, respectively, of GO coated sand composite. The presence of the peaks for C-Si and C-O-Si confirmed the interaction between sand and GO. During each coating, the peak position of C-OH shifted negatively, but the peak area decreased for GOS1 as compared to that of GO. In contrast, the peak area for C-OH increased for both GOS3 and GOS5. This may be due to the increase in the number of GO layers on sand particles during each coating. In GOS1, GO comes into direct contact with sand, leading to its involvement in the sand-GO interaction during heat treatment. The peak position of C-O-C shifted positively during each coating. The peak area and the peak width at half maximum of C-O-C decreased, possibly due to H-bonding with sand and GO. These three sand composites, GOS1, GOS3 and GOS5, removed fluoride at 46%, 54% and 68%, respectively. Fluoride removal occurs through the exchange of fluoride and hydroxyl groups of GO. The peak area of the C-OH decreases after the removal of fluoride, confirming that hydroxyl ions are involved in the removal process. Additional coating layers of GO (GOS3 and GOS5) are employed to remove fluoride from water. Due to its stability, S-OH groups do not participate in ion-exchange reactions as readily as C-OH groups. After fluoride removal, the samples show an additional peak at 288.5 eV, corresponding to the C-F bond.

Keywords: Fluoride removal, graphite oxide, sand, XPS

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