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Phytonanoremediaton using mangroves and iron nanomaterials to remove heavy metals

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Phytoremediation using nanoscale Zerovalent iron (nZVI) and mangroves for decontamination process

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Abstract:

Phytoremediation uses plants to clean up contaminated environments. Plants can help clean up many types of contaminants, including metals, pesticides, explosives, and oil. Our recent studies have shown that phytonanoremediation process is efficient combining mangroves and nanoscale zerovalent iron (nZVI) using contaminated soil with Cadmium and Lead. We evaluated the efficiency of the phytonanoremediation process using Avicennia germinans and Rhisophora mangle with and without nZVI to remove Cd and Pb in contaminated soils by inductively coupled plasma (ICP) analysis measurements. Comprehensive chemical and physical characterization of the resulting nZVI products after their exposure to Cd2+ was done. Further studies of the resulting nanostructures were completed using a photoelectrochemical solar cell (PSC) as the photoanode material. Incident photon-to-current efficiency (IPCE) and electrochemical impedance spectroscopy (EIS) analysis of these PSCs showed active photochemical properties in the ultraviolet range for the sample exposed to 30 ppm of Cd2+. Changes in the structure and chemical oxidation states of the species were observed in transmission electron microscopy (TEM), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS), and X-ray absorption spectroscopy analysis was attributed to these photochemical properties. These results show an alternative synthetic method for producing iron oxides for photocatalytic applications, and a possible strategy for reuse of nZVI after water remediation treatments. At CLS, we will evaluate fresh and aged nZVI together with Fe oxide model compounds, using synchrotron-based X-ray absorption (XAS) and X-ray fluorescence spectroscopy (XRF) to obtain both the relative oxidation state, using the absorption structure near edge X-ray images (XANES), well-extended regions (EXAFS), and quantitative speciation information regarding the types and proportions of mineral species present, from the extent analysis. On the other hand, the use of mangroves with nZVI to remove heavy metals with different concentrations will be evaluated using BioXAS and X-ray fluorescence imaging.

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