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Bioremediation of Soil Using New Approaches of Nanobiotechnology and Hybrid Materials from Agro-waste and Nanoparticles

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Extended Abstract

Nanotechnology is the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer scale. It opens up a wide array of opportunities in various fields like medicine, pharmaceuticals, electronics, agriculture and environmental bioremediation.

We developed a new method for the immobilization of Nauclea diderrichii seed waste biomass (ND) (an agro-waste) with eco-friendly mesoporous silica (MS) and graphene oxide-MS (GO + MS) nanoparticles, producing two new hybrid materials namely: MND adsorbent for agro-waste modified with MS and GND adsorbent for agro-waste modified with GO + MS nanoparticles showed improved surface area, pore size and pore volume over those of the agro-waste. Agro-materials are known to have abundant content of lignocellulose, which essentially impacts high removal efficiency of toxic metal ions. The use of agro-wastes as biosorbents has a drawback known as "bleeding" resulting from biodegradation of the biomass. In recent times mesoporous materials have been applied in advance oxidation processes and adsorption, including functionalized graphene oxide (GO) nanoparticles to selectively adsorb various pollutants. However, GO nanoparticles and mesoporous materials are expensive and are thus not cost-effetive as adsorbent (Witula T et al., 2007). Therefore, we thought that modifying GO and mesoporous silica (MS) nanoparticles with cheap materials rich in functionalities will reduce their costs without compromising their efficiency to remove micropollutants from aqua systems. The abstractive potential of the new hybrid materials was explored for uptake of Cr(III) and Pb(II) ions. Analysis of experimental data from these new hybrid materials showed increased initial sorption rate of Cr(III) and Pb(II) ions uptake (Han R et al., 2006). The amounts of Cr(III) and Pb(II) ions adsorbed by MND and GND adsorbents were greater than those of ND. Modification of N. diderrichii seed waste significantly improved its rate of adsorption and diffusion coefficient for Cr(III) and Pb(II) more than its adsorption capacity. The rate of adsorption of the heavy metal ions was higher with GO + MS nanoparticles than for other adsorbents. Kinetic data were found to fit well the pseudo-second-order and the diffusion-chemisorption kinetic models suggesting that the adsorption of Cr(III) and Pb(II) onto these adsorbents is mainly through chemisorption mechanism (Shah B et al., 2013). The results obtained indicates that very high specific surface area and pore structure of the hybrid materials were responsible for its excellent toxic metal ions uptake capacity with respect to the agro-waste. It was discovered that the uptake of Cr(III) and Pb(II) ions by GND adsorbent was the fastest of all the adsorption processes. This implies that the industrial application of GND adsorbent for the treatment of effluent will yield very high turnover efficiency for a short period of time. Analysis of kinetic data with the homogeneous particle diffusion kinetic model suggests that particle diffusion (diffusion of ions through the adsorbent) is the rate-limiting step for the adsorption process. In conclusion this method demonstrates the potential of use of this hybrid material to remove or neutralize pollutants from a contaminated site especially to remove toxic metals such as lead Pb(II) and chromium Cr(III).

References

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