IL-FUNCTIONALIZED LAYERED DOUBLE HYDROXIDE: SYNTHESIS, CHARACTERISATION AND APPLICATION AS ADSORBENT MATERIALS FOR PALLADIUM RECOVER

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Abstract

Palladium (Pd) made part from the platinum group metals (PGMs), which are precious metals used in a wide range of industrial applications, being considered indispensable in cutting-edge technology. [1] While their natural resources are limited the demand for these metals increases. [2] The content of the precious metals in secondary resources was found to be much higher than their content in natural ores. To meet the continuously increasing demand for precious metals, in recent years, the recovery of PGMs from secondary resources is a potential solution.

Introduction

It is well known that the sorption processes are more appropriate for the recovery of metal ions from diluted solutions. An efficient adsorbent material must meet the following conditions: high adsorption kinetics, excellent selectivity, high adsorption capacity, thermal and chemical stability, and easy synthesis. These properties are met by layered double hydroxides (LDH). [3, 4] For more than a decade, studies have been carried out in the functionalization of different solid supports with different functional groups to increase the adsorption capacity and the selectivity of these materials. To this end, the researchers attention was focused on the use of ionic liquids (ILs) in the processes of solid supports functionalization due to the unlimited possibilities of tunability/design of new ionic liquids for specific applications and needs, insignificant volatility, high thermal stability and wide ionic and electrochemical conductivity. [5, 6] In this context, the present paper aims at the synthesis and characterization of Mg_3Al and and their functionalization with ILs (methyl trialkyl (C8-C10) ammonium chloride in order to obtain adsorbent materials with high efficiency in the removal process of PGMs from aqueous solutions.

Experimental

The studied LDHs were synthesized by the co-precipitation method at low supersaturation. The functionalization of the synthesised LDH was performed in two ways: ultrasonication and co-synthesis. The obtained adsorbent materials were subjected to structural and morphological characterization using X-ray diffraction (XRD), N_2 adsorption-desorption analysis, Fourier-transform infrared (FTIR) spectroscopy and by thermal analysis.

Results and discussion

The results of the characterization proved the fact that through ultrasonication, is assured a uniform distribution of the ILs onto the surface of the LDHs, while via co-synthesis is obtained an impregnation of the IL between the LDHs layers, which will bring a higher stability of the obtained material. Palladium adsorption studies onto the studied materials were conducted in batch mode, performing equilibrium, kinetic and thermodynamic studies. The adsorption capacity increases with the increasing contact time, increasing temperature and increasing equilibrium concentration of Pd(II).

Conclusions

The presence of ionic liquid significantly improves the efficiency of Mg_3Al in the recovery process of Pd(II) ions from aqueous solutions. The adsorption kinetics were better described by the pseudo-second-order kinetic model compared to the pseudo-first-order kinetic model. The experimental data showed a good fit with the Langmuir isotherm. The adsorption capacity increases as follows: Mg_3Al << Mg_3Al IL-US < Mg_3Al IL-COS.

By correlating the results obtained in the characterization process of adsorbent materials with the results obtained from kinetic, thermodynamic and equilibrium studies, we can conclude that in the case of the raw Mg_3Al sample, Pd recovery occurs through a physisorption mechanism, as it is adsorbed in the pores of the material. In contrast, in the case of IL (Methyltrialkylammonium chloride) functionalized samples, Pd recovery is due to a chemosorption process, indicating that the functional groups of the ionic liquid confer a beneficial influence on the adsorbent material.

Key Words: *platinum metals group; adsorption, layered double hydroxides, ionic liquids; functionalization.*

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Acknowledgement

This work was supported by a grant of the Romanian Ministry of Education and Research, CNCS - UEFISCDI, project number PN-III-P1-1.1-TE-2019-1555, within PNCDI III.