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Effect of Polymer Backbone Chemical Structure on Metal Ions Binding by Imidazolylmethyl Derivatives

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Abstract

Sorption properties of poly(N-(5-methyl-4-imidazolyl)methylallylamine (PAA) and poly(N-(5-methyl-4-imidazolyl)methylethylenimine) (IMPEI) have been investigated and compared with those of imidazolylmethyl derivative of natural aminopolymer chitosan (IMC). We have shown that the structure of polymer backbone has a pronounced effect on sorption of both transition metal cations and noble metals by imidazolylmethyl derivatives. It was shown that sorption of Au(III) and Pt(IV) by all imidazolylmethyl derivatives is accompanied by changes in metal oxidation states. The highest content of more oxidized species - Au(III) and Pt(IV) was found in IMC, which showed the lowest sorption capacity. Efficacy of noble metals elution with HCl/thiourea solution changes in the row IMC>IMPAA>IMPEI, showing low applicability of IMPEI for recovery of gold and platinum ions in sorption/regeneration cycles despite its highest sorption capacity toward all noble metal ions.

Sorption capacities toward transition metal cations change in the following row: IMPEI>IMC>IMPAA. The effect of polymer structure on sorption capacities of IMPEI, IMPAA, and IMC is much stronger for divalent cations than for monovalent silver ion. DFT calculations have shown that coordination of Ag^+ ion by all derivatives occurs via formation of two Ag-N coordination bonds with N-atoms of imidazole ring and amino group of the polymer backbone, while contribution of electron-donor atoms of IMC and IMPEI backbone to coordination of divalent ions is remarkably higher.

Keywords: imidazole derivatives; chitosan; metal ions sorption; reduction; XPS

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