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N-aminoguanidine modified persimmon tannin: A new sustainable material for selective adsorption, preconcentration and recovery of precious metals from acidic chloride solution

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HIGHLIGHTS

- ▶ Preparation of new adsorption material by the introduction of N-aminoguanidine ligands on the surface of persimmon tannin.
- ▶ High selectivity of the material towards Au(III), Pd(II) and Pt(IV) over base metals from acidic chloride media.
- ▶ Reduction of adsorbed Au(III) to elemental gold and very high loading capacity of the material.
- ▶ Highly efficient sorption material having high selectivity and adsorption efficiency than that of commercial adsorbents.

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ABSTRACT

A new adsorption gel has been developed by immobilizing N-aminoguanidine (AG), a chelating ligand, on persimmon tannin extract through consecutive reactions. Adsorption behavior of the gel was investigated for the adsorptive separation and recovery of precious metal ions from varying concentration of HCl medium. The adsorption isotherms of precious metal ions on the gel were described by the typical monolayer type of Langmuir model and the maximum adsorption capacities were evaluated as 8.90 mol kg^{-1} for Au(III), 2.01 mol kg^{-1} for Pd(II) and 1.01 mol kg^{-1} for Pt(IV). Real time applicability of the gel was examined for the recovery of precious metals from actual leach liquor of e-waste leached with chlorine containing hydrochloric acid. The gel was found to be highly efficient and selective for the uptake of targeted metal ions in the presence of excess base metal ions and also exhibited superior selectivity over commercially available anion exchange resins.

1. Introduction

Development of a sustainable environment for future generation requires a holistic approach to recycling of precious and valuable materials. Recovery of valuable metals from a wide variety of sources such as primary sources (ore) and from secondary sources like electronic scraps and industrial wastes has been the subject of great interest and also has been an imperative issue (Hagelüken and Meskers, 2009; Li et al., 2007). Since the waste material contains various coexisting metals, selectivity towards target species plays a vital role. Among the numerous techniques for preconcentration and separation of precious metals, adsorption has been extensively employed and proven to be more effective compared to other techniques (Anticó et al., 1994; Hubicki and Wołowicz, 2009; Myasoedova et al., 1985; Shah and Devi, 1997). In recent years, increasing efforts have been devoted to the development of new resins containing selective functional groups, which have been applied to hydrometallurgical processes for metal ion adsorption (Anticó et al., 1994; Myasoedova et al., 1985; Shah and Devi, 1997). However, challenges for the implementation of these adsorbents as commercial adsorbents for metal recovery face various difficulties such as low metal binding capacity, poor selectivity, costly operation, generation of secondary sludge materials, and so on (Cortina et al., 1998; Wołowicz and Hubicki, 2009; Zuo and Muhammed, 1995). Consequently, it is necessary to explore new separation materials and methods for these purposes.

In recent years, waste biomass-based low costs adsorbents have been received increasing attention as a versatile class of adsorbent (Volesky and Holan, 1995). One of the most striking advantages of using waste biomass materials is that they are easily available in huge quantity at cheap cost. Further, since they are the natural

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