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Modified poly(styrene-*co*-maleic anhydride) resin for precious metal recovery

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Gold recovery by ion-exchange using a modified polymer which can be alternatively functionalized to incorporate superparamagnetic properties

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BRIEF DESCRIPTION

A modified poly(styrene-*co*-maleic anhydride) (PSMA) resin utilized in an ion-exchange process to separate gold chloride ions from acidic gold slurries is described in the invention.

A method of making the polymer is disclosed, and the polymer that has ability to be formed such that it encapsulates magnetite to allow it to respond positively to an applied magnetic force to retain the loaded polymer out of solution. The polymer is a nano-particle that has high selectivity and has been proven through lab trials to have highest affinity for gold in acidic PGM's slurry

TARGET MARKET

- Resin manufacturing
- Gold tailings treatment processing
- Treatment plants in mines
- e-Waste processing
- Precious metal refineries

VALUE PROPOSITION/ BENEFITS

•The high reactivity of the maleic anhydride groups in the copolymer toward nucleophilic reagents enables the manufacturing of new materials with a variety of functionalities depending on desired applications.

•The modified PSMA offers high selectivity and an efficient process for extraction and recovery of $AuCl_4$ ions, especially in aqueous solutions with low precious metal content.

•The modified PSMA can be easily

synthesized by a simple post-polymerization reaction using inexpensive and readily available raw materials.

UNIQUE CHARACTERISTICS

•The modified forms of PSMA, will allow it to be used in gold extraction or other applications.

•Modified PSMA in the form of nanoparticles with a superparamagnetic core, allow separation of the polymeric material from solution (after gold adsorption) using a magnetic field.

TECHNICAL DESCRIPTION

Poly(styrene-*co*-maleic anhydride)(PSMA) is a commercially available polymer, which can be found in various grades with maleic anhydride contents between 6 and 50 % and molecular weights between 1000 and 300 000 g/mol. Modified PSMA nanoparticles with functional groups exposed on its surface have been synthesized starting as copolymers of styrene and maleic anhydride with maleic anhydride contents ranging from 20 – 35 wt%.

Surface functionalized poly(styrene-*co*-maleimide) (PSMI) nanoparticles were synthesized by thermal imidization of the poly(styrene-*co*-maleic anhydride). Stable water-based dispersions were obtained containing spherical, mono-disperse PSMI nanoparticles with a narrow size distribution and average diameters of 50 ± 5 nm. The specific surface area of the bulk PSMI nanoparticles is 88.1 ± 2.2 m^2/g with an average pore diameter of 82 Å. Elemental analyses confirmed complete conversion of PSMA into the PSMI derivative. The $[AuCl_4]$- batch sorption extraction occurred with extremely fast sorption kinetics with high dependence on the agitation rate and achieved maximum gold loading capacity of 1.76 mmol/g (347.7 mg/g) based on Langmuir and Freundlich isotherm models analysis.

Formation of superparamagnetic properties in the polymer

Alternative method revealed that the PSMI nanoparticle can also be functionalized to have magnetic properties. Superparamagnetic magnetite (Fe_3O_4) nanoparticles with a high degree of crystallinity and phase purity were synthesized by a chemical co-precipitation of Fe^{2+} and Fe^{3+} salts. The average diameters of the obtained Fe_3O_4 nanoparticles were about 7 – 8 nm. After PSMI nanoparticle synthesis in the presence of the Fe_3O_4 nanoparticles, TEM analysis confirmed that the magnetically responsive PSMI nanoparticles consist of magnetite core – polymer shell structure.

Elution

The adsorbed gold chloride ions were recovered by treating with nitric acid as an eluent with high recoveries that increased with the steady increase in HNO_3 concentration.

INNOVATION STATUS

Granted Patents

Australia- 2012208346 , China- 201280005531.9 , Netherlands- 2665757, New Zealand- 612480 , United States- 9,700,883, South Africa- 2013/04309, EU

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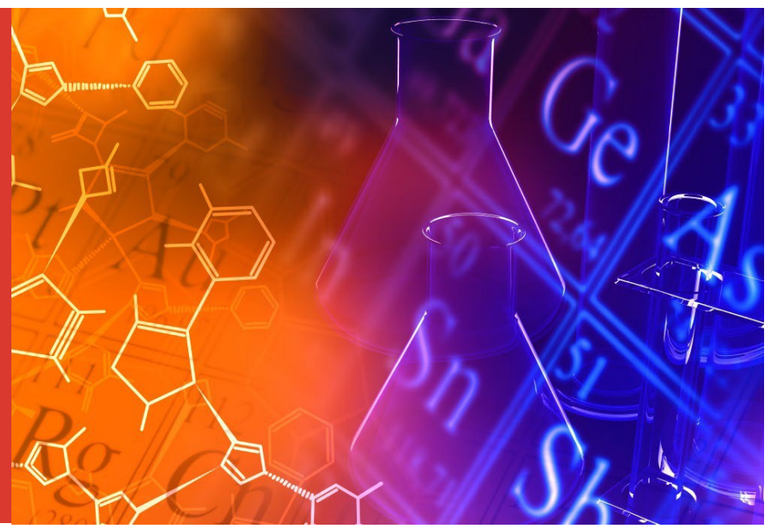
Brazil- BR 11 2013 0180846

Ion-exchange using poly(styrene-*co*-maleic anhydride) to extract gold chloride ions from acidic aqueous solution



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