A novel rare earth separation from monazite elements by magnetic nanohydrometallurgy

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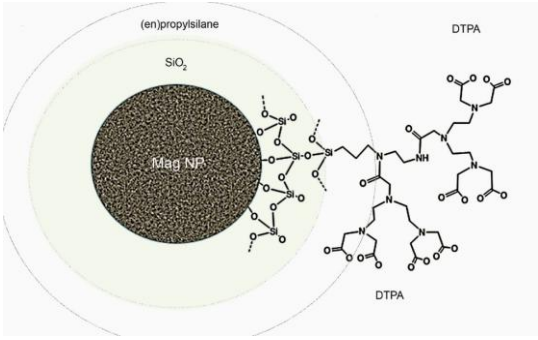
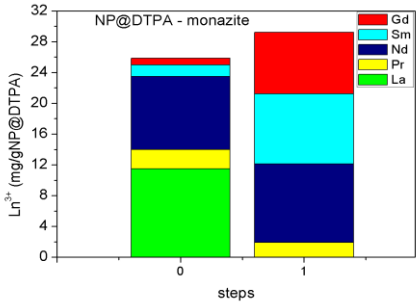
Magnetic nanohydrometallurgy [(1)] is based on the use of functionalized superparamagnetic nanoparticles for capturing, concentrating and processing metal ions. The technique can be applied to the separation of rare earths, by exploring the variation in the stability constants of the complexes along the lanthanide series. For this purpose, magnetite superparamagnetic nanoparticles (MagNPs) were specially developed using the coprecipitation method, and successively silanized with tetraethoxysilane and ethylenediaminepropylsilane, and finally functionalized with DTPA. To prevent the formation of the lanthanide hydroxydes, the



(1)

2-(4-morpholino)ethanesulfonic buffer, MES, has been prefered, because of its suitable pKa = 6.15 and non-complexing behavior. Our method is based on the surface modification by a powerful complexing agent DTPA (presumably involving double coordination) as indicated in scheme 1, leading to a higher amount of lanthanide and a better efficiency of separation. It is already shown that starting from Nd/La 50/50 % mixtures (as nearly found in the monazite ores), it was possible to obtain an enrichment process the amount of lanthanium ions was no longer detectable by the EDXRF technique (> 98/2 %). [(2)] The next step, from monazite elements on a equimolar mixture, it is possible to see the separation of light elements as lanthanium, neodymium and gadolinium . In a second stage, the elements percentages in a solution containing on monazite ores (23% of La, 5% of Pr, 19% of Nd, 3% of Sm and 1,7% of Gd) were tested in a capture from magnetic nanoparticles and the results indicate that it is possible to make the enrichment of all the rare earth elements (scheme 2) that contain on the monazite ores in a real concentration. In conclusion, the capture of rare earths with magnetic nanoparticles is feasible, and by using the pH control and the discrimination of the ions



(2)

by DTPA, is possible to perform their separation using magnetic nanohydrometallurgy, also using the maximum capacity of the nanoparticles with the results of the isotherm, with 66mgLn 3+ /gNP@DTPA.

1. Condomitti, U; Zuin, A.; Silveira, A.T.; Araki, K.; Toma, H.E.; *Hydrometallurgy*, **2012**, *125*, 148.
2. Almeida, S. N.; Toma, H.E.; *Hydrometallurgy*, **2016**, *161*, 22.

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