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Core-shell magnetic zeolite particles from red mud

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Abstract
Zeolites are microporous, aluminosilicate minerals extensively used in industry. An interesting feature about these materials is their good performance as ion exchangers, which allows the capture of metal cations considered toxic and harmful, for example. In this work, magnetic zeolites from LTA group were prepared using the magnetic particles found in the red mud resulting in a core-shell system. The perspective is to apply the obtained composites in water treatment and to be able to remove them taking advantage of their magnetic behavior.

Key words:
Magnetic zeolites, Water treatment, Environment

Introduction

For more than half a century, zeolites have been exhaustively studied and applied as molecular sieves, catalysts and adsorbents conquering a considerable space in various branches of the modern industry. Their structure is basically composed of silicon and aluminum tetrahedra, SiO_4 and AlO_4, giving rise to crystalline structures with different channels and pores.[1] The aluminum is the major responsible for the cation exchange capacity of the zeolites once they generate a negative charge in the framework[1]. Zeolites from LTA group have Si/Al molar ratio around 1 and have been already used in water treatment to adsorb toxic metals present in some residues[2].
The industrial production of alumina generates highlights alkaline waste known as the red mud. This material contains magnetic particles composed mostly of iron oxides, such as hematite, pyrite and goethite. The rejected product was used in the synthesis gel and the zeolite crystals grown in the particles' surface resulting in a core-shell composite. The magnetic behavior of the composites can be used in their own separation from the treated water.

Results and Discussion

The zeolites from LTA group were prepared following a standard protocol from the research group. A mixture of silicate, aluminate and sodium hydroxide solutions was homogenized and the magnetic particles from the red mud were added to the gel that was hydrothermal treated. The final materials were washed, dryed and then analyzed by scanning electron microscopy (SEM), energy dispersive spectroscopy (SEM-EDS), X-ray powder diffraction (XRD) and thermogravimetry (TG).

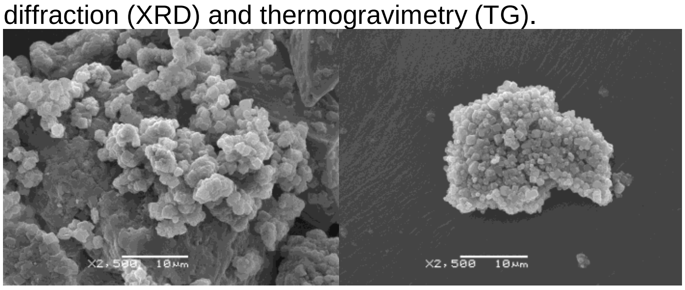

Figure 1. SEM images of the composite.

Through the images in Figure 1, the characteristic crystals of LTA zeolites (cubic whiter) could be seen on the surface of the magnetic particles (darker surface). Also, SEM-EDS spectra were used to evaluate the surface of the composite, showing that the edge of the particle has a major composition of silicon and aluminum, an evidence of the presence of the zeolite on that region. Inside the particle, an expected predominance of iron and titanium could be noted. The image and the spectra of the boundary region are shown in Figure 2.

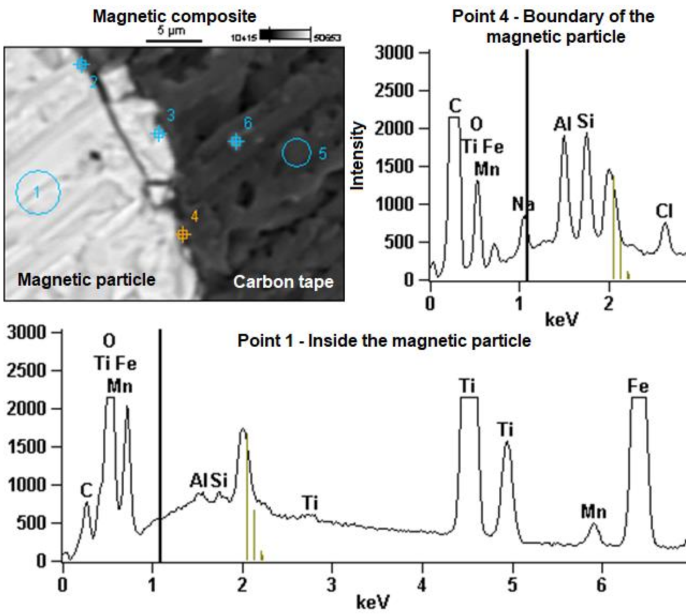

Figure 2. SEM-EDS spectra of the surface region.

The XRD profiles and TG curves from the particles, the composites and their respective zeolites confirmed the preparation of a mixed system with the presence of both materials.

Conclusions

The syntheses of the magnetic zeolite from the LTA group were successfully reached using the particles present on the red mud. The SEM images and the SEM-EDS spectra showed the obtaining of a composite formed by zeolite crystals over the particles' surface, also the composition of the boundary region in this core-shell system.

Acknowledgement

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