RECOVERY AND VALORIZATION OF SILICA FROM FLUORO-DERIVATIVES INDUSTRY WASTE FOR ADVANCED TECHNOLOGICAL APPLICATIONS

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In recent years, the recovery of silica from waste or end-of-life products has become a challenging issue as an effective waste management strategy and sustainable circular economy model. In this context, the aim of the present work is the collection and study of silica generated as by-product from the recovery process of hexafluorosilicic acid (H_2SiF_6 or FSA), a hazardous waste generated in fluoro-derivatives and phosphate industry[1]. The main goal is the modification of silica nanoparticles, obtained from waste by chemical, mechanical or thermal processes, in order to impose specific structural and morphological properties such as size, shape and porosity on them. The project focuses on two main applications: i) the use of silica as an inorganic reinforcing filler for elastomeric nanocomposites for the tire industry; ii) meso- or macro-porous silicate materials, with high mechanical strength for applications in wastewater treatment or catalyst support. FSA-derived silica with high surface area and controlled morphological and textural features was obtained by varying temperature (3-20°C), pH (7.8-10), and drying conditions (Fig. 1a). Upon incorporation in Styrene Butadiene (SBR) matrix, the reinforcement mechanism of the filler system was analyzed by studying the vulcanization curves (at 170°C for 15 min.), showing comparability with those of rubber nanocomposites containing commercial silica filler used in the rubber industry. The mechanical behavior at low deformation of nanocomposites, acquired by determining the strain dependence of the shear modulus G', confirms the good properties, which correspond to those of commercial references. Meso/macro-porous silica with tailored porosity was prepared using organic template (e.g. PEG, CTAB) in FSA solution prior to ammonia addition and then thermally treated at 550 °C to remove the template and condense primary particles. The porous architecture of the obtained materials was evaluated by Hg porosimetry, N_2 physisorption, as well as by TEM and SEM analysis (Fig. 1b), while preliminary experiments revealed interesting adsorption properties in rare earth elements recovery from aqueous solutions (Fig. 1c).

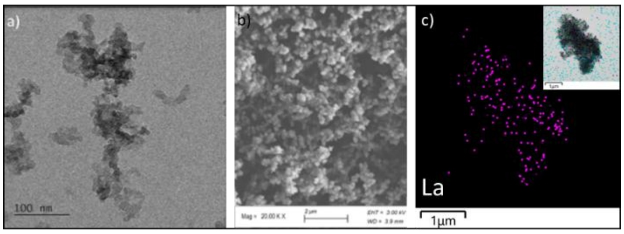

Figure 1 (a) TEM image of FSA silica applied as rubber filler; (c) SEM images of macroporous FSA silica sample; (d) EDX images showing La adsorption on FSA silica

Results indicate that FSA silica owns interesting features alongside comparable performances to commercial samples, allowing to consider it as valuable and convenient alternative to conventional silica precursors in large scale manufactures.

References

[1] M. A. Vacca, C. Cara, V. Mameli, M. Sanna Angotzi, M. A. Scorciapino, M. G. Cutrufello, A. Musinu, V. Tyrpekl, L. Pala, C. Cannas, ACS Sustain. Chem. Eng. 2020, 8, 14286–14300.