

GEOPOLYMER-ZEOLITE COMPOSITES FOR CO₂ ADSORPTION

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Geopolymer-zeolite composites were produced mixing different geopolymer matrices with a synthetic commercial Na13X zeolite, to combine the functional microporosity of the zeolite with the mesoporosity of the geopolymer matrix, with the further possibility to consolidate the zeolite powder.

The new materials were designed and produced in forms of monoliths to be used as adsorbents for low temperature CO₂ capture applications.

A potassium or sodium silicate activating solution was used to produce the metakaolin-based geopolymer matrices, then mixed with the synthetic zeolite used as a filler. As geopolymers can be regarded as the amorphous counterpart or precursor of crystalline zeolites, it is important to underline the chemical affinity between these two constituents. As a matter of fact, the morphological characterization evidenced the presence of geopolymer nanoprecipitates covering zeolite particles for the K-based composite, while in the Na-based composite the formation of a NaA zeolite phase was evidenced (Fig. 1).

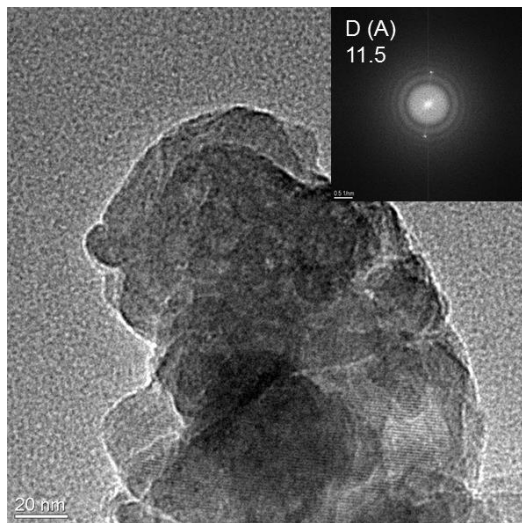


Figure 1 – High resolution TEM image of newly formed NaA phase.

The composites were deeply characterized in terms of macro- and microstructure, structural composition, porosity, specific surface area and CO₂ adsorption capacity and selectivity. The most promising formulations gave compact porous monoliths with a mechanical resistance up to 17 MPa and a 3-dimensional structure of interconnected open pores with a wide range of porosity (from 5 Å to 2 mm).

The surface area analysis showed that the geopolymer-zeolite composites have characteristics of Type I isotherms of microporous solids with specific surface area values quite high in the order of 200 m²/g.

The adsorption performances were determined through a dedicated pressure-decay apparatus and by thermogravimetric analysis. The results highlighted as the CO₂ capacity of Na-based composite resulted significantly larger (2-3 times) than K-based sorbents, approaching the values obtained for pure synthetic Na13X zeolite.

Na-based composite revealed also a synergistic effect, indeed the CO₂ capacity was approximately 20% larger than the value expected by averaging those of the constituents. Such effect is mainly attributed to the large interaction among the phases (zeolite NaA and Na13X and the geopolymer matrix) obtained by the effective chemical mixing achieved during the geopolymerization reaction.