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Synthesis and Characterisation of Fe-MW Carbon Nanotubes – Nanocrystalline NaY Zeolite

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Extended Abstract

Faujasite Y, a highly versatile zeolite is widely used as catalyst in the petrochemical industry [1, 2]. Nanocrystalline zeolites are porous materials with discrete, uniform crystals with dimensions of less than 100 nm that have higher external surface areas and reduced diffusion path lengths relative to conventional micrometer-sized zeolite crystals [3]. Zeolites with particle size in the nanometer range have been recently subject of intense research [4, 5].

The present study covers the synthesis of nanocrystalline zeolite Y by applying a two-stage varying temperature synthesis without template under hydrothermal conditions through crystallization of gel in mesoporous system of functionalized multi-wall carbon nanotubes with iron nanoparticle (Fe-MWCNT) with an internal diameter of 10~30 nm. Those, purified MWCNTs are first functionalized with mono-and tricarboxylic aryl diazonium salts generated in situ, then iron nanoparticles are formed using iron (II) acetate. The properties of the resulting materials are investigated using different characterization techniques (XPS, TEM, PXRD, and FESEM). Homogeneous distribution of iron nanoparticles on MWCNTs is evidenced with a Gaussian mean diameter of~ 2.7±0.2 and~ 3.8±0.3 nm for monocarboxylic and tricarboxylic functionalizations, respectively.

The obtained Fe-MW carbon nanotubes are dispersed in colloidal silica and sodium aluminate mixture to synthesize the small and uniform zeolite crystals. The crystal size of zeolite Y is influenced by temperature, aging time, alkalinity, water content and mesoporous system. The synthesized nanocomposite (NaY nanocristalline-Fe-MWCNT) is characterized by powder X-ray diffraction (PXRD), Fourier Transmission Infrared Sprectroscopy (FTIR), Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM) and Nitrogen Adsorption. These characterizations show that the obtained nanocrystals possess the typical nanosized NaY zeolite structural characteristics combined with iron functionalized multi-wall carbon nanotubes. Moreover, it appears clearly that MW carbon nanotubes influence the crystal size of zeolite NaY. Indeed, the NaY zeolite synthesized in presence of Fe-MWCNT has larger XRD characteristic patterns.

The representative SEM images of the microcrystalline and nanocrystalline NaY zeolites obtained respectively in presence and without presence of iron functionalized carbon nanotubes show respectively large crystal size around 200 nm and small average crystal size of about 80 nm. The crystal size distribution of these zeolites appears to be uniform in both microcrystalline and nanocrystalline NaY zeolites. Whereas, the obtained textural properties highlight a larger total surface area and porous volume for the nanocrystalline NaY. Indeed, the surface area of the latter is 865 m^2/g, which represents 20% of increase compared to the microcrystalline NaY.

The decrease in the crystal size to the nanoscale range produces changes in both textural and structural properties of the synthesized NaY zeolite. The presence of iron functionalized multiwall carbon nanotubes during aging process affects the zeolite crystals size by blocking their increase during crystallization.

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