Elaboration and characterization of modified sepiolites and their humidity sensing features for environmental monitoring

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Abstract

After a simple low cost wet chemical precipitation route under basic conditions and subsequent thermal treatment, different oxide/hydroxide nanoparticles (based onW^{4+}, Co^{2+}, Cu^{2+}, Gd^{3+}, La^{3+}, Mn^{2+}, Nd^{3+}, Sm^{3+}, Sr^{2+}, Y^{3+} and Zn^{2+}) were formed instead of Mg^{2+} ions onto the sepiolite ($Si_{12}Mg_8O_{30}(OH)_4.(H_2O)_4.8H_2O$) channels. The fact that these nanoparticles appear supported on an inert matrix makes it possible to avoid manipulation, agglomeration and harmful character that pure nanoparticles usually have.

Thermogravimetric–Differential Thermal Analysis (TG–DTA) combined with X-ray diffraction (XRD), nitrogen adsorption at −196 °C, Field Emission-Scanning Electron Microscopy (FE-SEM), Diffuse Reflectance UV–visible (DR-UV–vis) spectroscopy and Infra-Red (IR) spectroscopy were used to study the particle size distribution, the morphology and the composition of the modified sepiolites.

Sepiolite is known as a high specific surface area (SSA), that is why the thinking about using in sensors is a must. SSA decreases after leaching of sepiolite, whereas, after doping, some oxo/hydroxides formed, as confirmed by UV–vis spectroscopy that could contribute to the increase in SSA.

Humidity sensors were prepared in the form of pellets, where powders uniaxially pressed and thermally treated at 550 °C for 1 h then, interdigidated (IDE) gold electrodes were screen-printed.

Among the investigated compositions, tungsten-doped sepiolite seems to be the most interesting one, even, if its composition has to be optimized, in order to have responses for lower RH values. This is due to response towards relative humidity (RH) at room temperature starting from 40% RH.

In a future work, different amounts of precipitated particles will be investigated.