Fe_3O_4 Nanoparticles Embedded in Phase Change Materials

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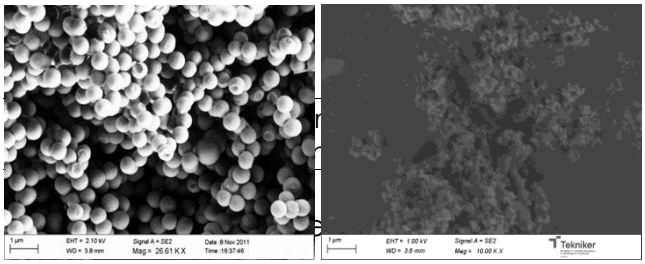
Phase change materials (PCMs) have the ability to release and absorb large amounts of thermal energy during their isothermal phase change. Because of this, they are able to store and release energy as heat and maintain stable temperatures, so they find their application in electronics, clothing and construction sector [1]. According to the material which releases the heat, PCMs can be categorized in organic compounds, hydrated salts and eutectic compounds, being paraffin waxes (n-alkanes) the most suitable ones, due to their high heat storage capacity, little overcooling, little volume change, good chemical and thermal stability, low vapor pressure, little corrosion of the storage vessel and low toxicity. However, they can suffer from liquid leakage, which limits their application. Proper encapsulation of PCMs using organic or inorganic supporting materials could be an effective way to overcome these kind of problem [2].

In different electronic devices, electromagnetic radiation and heat are released. Magnetic PCMs could alleviate these drawbacks due to their latent heat and electromagnetic shielding, as well as being able to be controlled by a magnetic field [3]. The aim of the present work would be to achieve a system of encapsulated organic PCMs containing magnetic nanoparticles (MNPs).

For this purpose, we have prepared NPs of magnetite, Fe_3O_4, as they have become the formulations preferred by the industry, due to their low toxicity and modulable magnetic response by two different routes. From precipitation in basic medium superparamagnetic ones (SPM-NPs) with sizes less than 20 nm and with no remanent magnetization have been obtained and ferromagnetic nanoparticles (FM-NPs), greater than 20 nm, with non-fluctuating magnetic moment and remanence, have been prepared by thermal decomposition of a metallo-organic precursor of iron(III) oleate. Both kinds of MNPs have been characterized by X-ray diffraction and transmission electron microscopy and their magnetic behavior has also been analyzed.

Both kind of MNP have been employed for the preparation of magnetic encapsulated PCMs, using a sol-gel method, in which hexadecane with a 0.5 – 5 % (in weight) Fe_3O_4 dispersion of NPs has been successfully encapsulated in silica spheres (Fig. 1).



The contents of PCM vary in the 55 – 76 % range and the size of the microcapsules obtained are around 50 μm. Magnetic measurements of the PCMs with embedded MNPs leads to the estimation of the amount of NPs loaded in the PCMs.

References

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