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Effect of additives on the synthesis of silica nanocomposite (NC) based on cobalt ferrite ($CoFe_2O_4$) magnetic nanoparticle (MNPs).

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Introduction

The silica glass obtained by Sol-gel route derived from the conventional hydrolysis and polycondensation of tetraalkoxysilanes yield silica gels, which can be converted into silica glass at relatively low temperatures (~1000 - 1500 ºC)1. Furthermore, this route allows the addition of new materials, like MNPs in the glass network, enabling to obtain Magnetic nanocomposites (MNC), which may have new properties. MNC based on MNP dispersed in a host matrix, own characteristics that are influenced by both, the size of the nanoparticles, such as by dispersion of these particles in the matrix.

In this work we synthesized magnetic nanocomposites based on silica xerogels and cobalt ferrite nanoparticles by Sol-gel route. We studied the influence of drying control chemical additives (DCCAs), like *N,N*-dimethylformamide (DMF) and fumed silica, the effectiveness of "washing" protocol and the effect of MNP in reactional medium at synthesis of silica glass by Sol-gel route.

Results and Discussion

The synthesis is conducted in two-steps method. In the first one, tetraethoxysilane (TEOS), 2-propanol, DMF, H_2O and HCL are putting in a three neck flask in molar ratio of 1:4:1:10:5,6 x 10^{-3}, respectively, in some samples were added fumed silica.[2] After the xerogel formation, some samples were "washed" before the aging stage. It consists in soaking the gel in a first washing solution S1 constituted by a mixing of water:ethanol (4:1 v/v) for 48 h, then transferring it into a second solution S2 made of TEOS (1:1 v/v) for 48 h. The xerogel is slowly dried at a fixed temperature.

We obtained xerogels prepared with silica precursors and modified with fumed silica and/or MNP.

In Figure 1, we see the influence of adding fumed silica and CoFe2O4 nanoparticles in gelation process. Both fumed silica and MNP increase the stability, avoiding fracture of the xerogels during the aging process. The presence of additives in xerogels allowed to obtain monolithic dried gels without fractures.

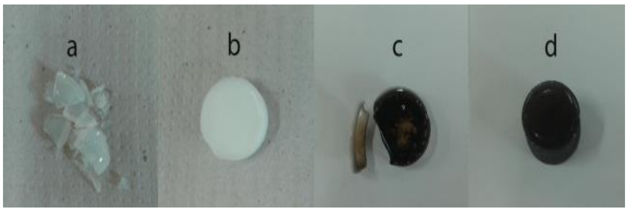

Figure 1. a. xerogel without fumed silica, b. xerogel with fumed silica, c. xerogel with MNP and d. xerogel with fumed silica and MNP.

In the figure2, it was possible to observe that the cobalt ferrite nanoparticles clustered during the gelation step, probably due to the dipolar magnetic interaction between the MNP, nevertheless, the xerogels exhibit good distribution of the MNP, with no concentration gradient noticeable to the naked eye.

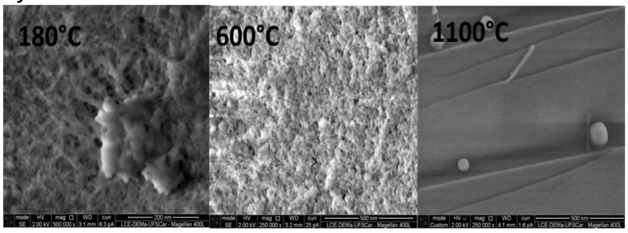

Figure 2. Scanning Electron Microscopy (SEM) of silica glass contain cobalt ferrite nanoparticles at several temperatures.

The "washing" process increase the mechanical stability in monolithic xerogels without fumed silica, however the increase in mechanical stability was not statistically significant when it was used in xerogels containing fumed silica.

Conclusion

Adding fumed silica to the xerogels avoid the fractures. The "washing" process increase the mechanical stability in monolithic xerogels without fumed silica, however the increase in mechanical stability was not significant when it was used in xerogels containing fumed silica.

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