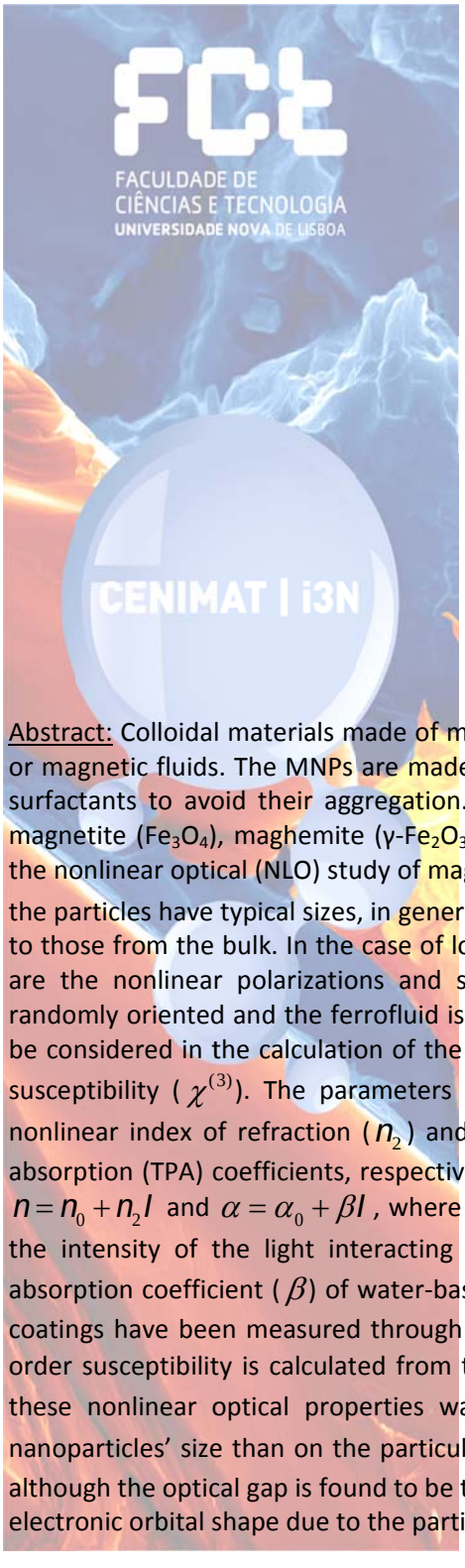

SEMINÁRIO

Data: 18 de Julho de 2014
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"Influence of nanoparticle size on the nonlinear optical properties of magnetite ferrofluids"

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Abstract: Colloidal materials made of magnetic nanoparticles (MNPs) suspended in a liquid carrier are known as ferrofluids or magnetic fluids. The MNPs are made of a magnetic core whose surface is electrically charged or coated with polymeric surfactants to avoid their aggregation. This process leads to the colloidal stability. The magnetic core can be made of magnetite (Fe_3O_4), maghemite (γ-Fe_2O_3), and ferrites, among other magnetic solids [1]. Besides the technological appeal, the nonlinear optical (NLO) study of magnetic colloidal systems is also interesting from the fundamental point of view. Since the particles have typical sizes, in general, between 10^{-9} and 10^{-7} m, some of their properties may change when compared to those from the bulk. In the case of low-order NLO effects, the physical parameters involved in the theoretical formalism are the nonlinear polarizations and susceptibilities. Without any applied magnetic field, the magnetic moments are randomly oriented and the ferrofluid is optically isotropic. In this case, the first relevant nonlinear contribution that has to be considered in the calculation of the total index of refraction (n) and absorption (α) of the material is the third-order susceptibility ($\chi^{(3)}$). The parameters that inform about the nonlinear third-order susceptibility of a material are the nonlinear index of refraction (n_2) and absorption (β). These parameters are also named optical Kerr and two-photon absorption (TPA) coefficients, respectively. The total index of refraction and absorption of the material may be written as: $n = n_0 + n_2 I$ and $\alpha = \alpha_0 + \beta I$, where n_0 and α_0 are the linear index of refraction and absorption, respectively, and I is the intensity of the light interacting with the material. The nonlinear index of refraction (n_2) and the two-photon absorption coefficient (β) of water-based ferrofluids made of magnetite nanocrystals of different sizes and with different coatings have been measured through the Z-scan technique [2], with ultrashort (femtoseconds) laser pulses. Their third-order susceptibility is calculated from the values of n_2 and β. The influence of different particles' coatings and sizes on these nonlinear optical properties was also investigated. The values of n_2 and β depend more significantly on the nanoparticles' size than on the particular coating. We observe a decrease of β as the nanoparticles' diameters decrease, although the optical gap is found to be the same for all samples. The results are interpreted considering modifications in the electronic orbital shape due to the particles' nanosize effect [3].

References

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3. D. Espinosa, L.B. Carlsson, S. Alves, and A.M. Figueiredo Neto, *Phys. Rev.*, **88**, 032302 (2013).