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Cell Viability of Hydrothermally Synthesized $Mn_{0.75}Zn_{0.25}Fe_2O_4$ Coated with Thetraethyl Orthosilicate (TEOS).

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$Mn_xZn_{1-x}Fe_2O_4$ presents a strong dependence between Mn and Zn doping contents where the magnetic moment of the materials depends directly on the occurring reaction and methodology applied for the synthesis [1]. Hydrothermal method evidence an easy, quick and cheap reaction, also kept spherical shape homogeneity, which is essential to assure multi-applications of the particle synthesized [2]. To employ these nanoparticles for medicinal application the surface modification is important. The coating over the nanoparticle (NP) surface is also necessary to enhance the stability and solubility of those nanoparticles in aqueous media as well as to impart them with biological properties and functionalities [3]. The present works details the effect of surface modification of synthesis methods on the morphology and surface functionalization of hydrothermally synthesized $Mn_xZn_{1-x}Fe_2O_4$ (MZF) with x = 0.75 for biomedical application. Highly crystalline and pure MZF were synthesized via hydrothermal process for the production of smaller size nanoparticles. Hydrothermal process has been carried out at 140°C temperature for 1h at 1500 psi pressure using nitrate precursors. The surface of the MZF was successfully modified with Thetraethyl orthosilicate (TEOS). This modification over the nanoparticles enhance their surface change and physical structure with more active chemical groups by making them adoptable to be supplied on biological models. TEOS provides a spherical core-shell nanoparticles. Use of this material coating over nanoparticles surfaces increases their biocompatibility and control distance between core particles, which has been widely used due to enhance the colloidal stability. The X-ray diffraction (XRD) (XRD, Philips X'pert Diffractometer) with CuKa radiation (l= 1,54 Å) and scanning speed of 0,5 grades/min analysis revealed the crystallinity and purity of the samples. Crystal's size was determinate with Scherrer's formula: $D= 0.9\lambda/\beta\cos\theta$, where λ is X ray wavelength, β is the FWHM and θ is the diffraction angle. SEM (JEOL-JSM-6390LV / LGS) micrographs were used to evaluate the particle size distribution with and without TEOS coated nanoparticles (Figure 1). To measure the stability and particle size distribution of prepared nanomaterial in aqueous medium dynamic light scattering (DLS) and Zeta potential were taken. The FTIR (Frontier FT-IR / NIR, Perkin Elmer Spectrometer) spectra was carried to ensure the surface modification of the prepared materials (Figure 2) and to determine cell viability the colorimetric MTT (570nm) metabolic activity assay on HeLa cells was performed.
Colloidal probe determinate with Z potential evidenced the negative change of nanoparticles synthetized when those are suspended on water but due its attribute, this low Z potential obtained as -21, could determinate it's colloid would form aggregates and those will request a mechanical treatment to establish a colloid.

This study gives remarkable references as Mn synthetized hydrothemaly and functionalized with TEOS for biomedical applications shows an homogeneous dispersion before coating, MTT probes for cellular viability shows that is not evidence of cytotoxic effect at used concentration while NP are dispersed on water but NP dispersed on ethanol show an antagonism behavior producing the highest cytotoxic effect on HeLa cells cultures (Figure 3) [4].

References:
[1] Kaman, O., *et al*. Journal of Magnetism and Magnetic Materials, 427 (2017), p. 251.
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[3] Vanessa Pilati, *et al*. The Journal of Physical Chemistry C 122 (2018), p. 3028.
[4] Authors acknowledge DR Moises Martinez Velazques, CIATEJ for their support of HeLa cell measurements.

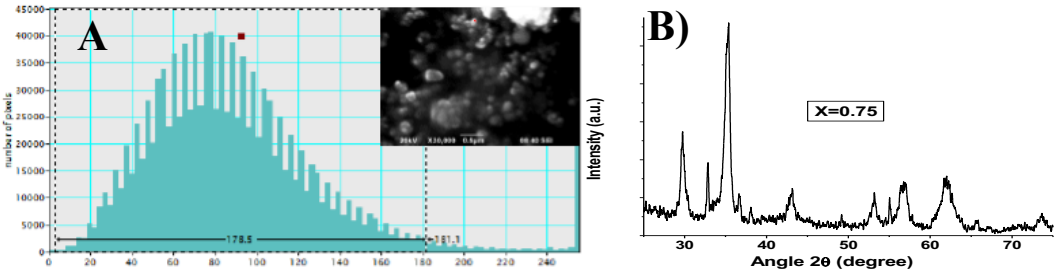

Figure 1. A) Size distribution histogram of coated NP (a; left) and SEM micrograph which shows spherical morphology (a; right), B) XRD pattern shows NP synthetized are doped with Mn and Zn on 0.75 and 0.25 respective concentrations according with the 10-0467 JCPDS card (b).

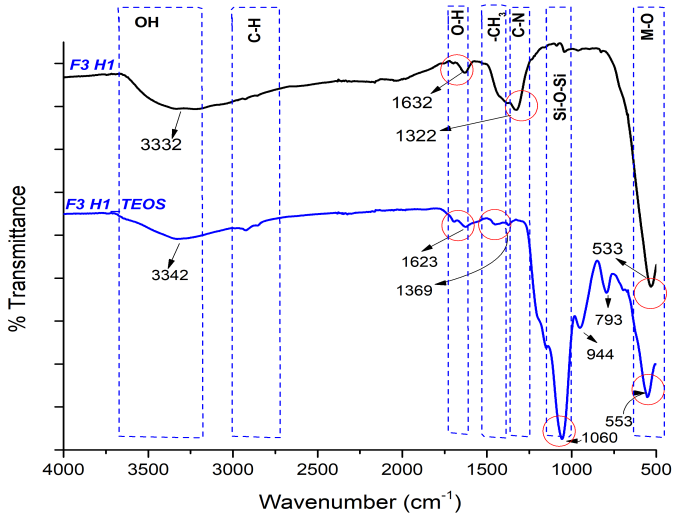

Figure 2. FT-IR Mn-Zn ferrites interferogram which shows comparatively presence of functional groups (TEOS with remarkable Si-O-Si groups).

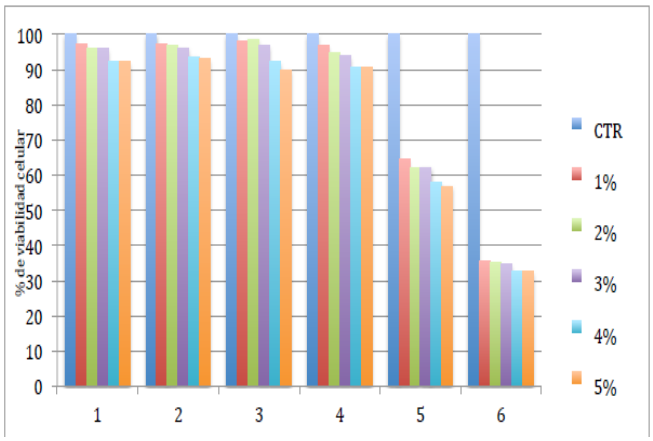

Figure 3. MTT results for biomedical biocompatibility testing after 24h incubation on HeLa cells with five concentrations (1 to 5%) of six different aqueous solutions.

Table 1. Functional groups localization on NP.

Fuc. Grp / Sample	OH	NH_2	C-H	CH_3	C-N	Si-O-Si	Si-OH	M-O	Coating Molecule	Diagram
F3 H1	✓	✗	✗	✗	✓	✗	✗	✓	Non-Coated	
F3 H1_TEOS	✓	✗	✓	✓	✓	✓	✓	✓		

Table 2. NP concentrations & solvent utilized.

Sample ID	*Sample (NP)*	*Aqueous phase*
1	*10 mg/ml*	*Water (100%)*
2	*10 mg/ml*	*Glutamic acid + DI Water (50-50%)*
3	*10 mg/ml*	*Citric acid + Water (50-50%)*
4	*10 mg/ml*	*Hexane + Water (50-50%)*
5	*10 mg/ml*	*Ethanol + Water (50-50%)*
6	*10 mg/ml*	*Ethanol (100%)*

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