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Structural And Biological Evaluation Of Iron Oxide-Dextran Nanostructures Thin Films

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ABSTRACT

Due to their outstanding properties and their potential use in biomedical application, iron oxide nanoparticles and their composites have received increasing attention in the last years. Nanophase composite materials exhibit physical and chemical properties which differ considerably from bulk materials. The size effect and the surface chemistry play a major role in the biological applications. To control the surface properties of iron oxide nanoparticles, coating is applied with a biocompatible polymer during or after the synthesis process. This study is focused on the obtaining of the polymer nanocomposite thin films containing iron oxide nanoparticles. Another goal of this research was the study of the physico-chemical and biological properties of layers based on iron oxide nanoparticles (IONPs) in a dextran matrix. Structural and morphological properties of dextran coated iron oxide thin films were investigated by X-ray diffraction (XRD) and scanning electron microscopy (SEM). The elemental composition of iron oxide-dextran thin films was investigated by X-ray Photoelectron Spectroscopy (XPS), Energy Dispersive X-ray Spectroscopy (EDS) and Glow Discharge Optical Emission Spectroscopy (GDOES) . The biological studies were conducted on HepG2 cells. The morphological evaluation and viability of HepG2 cells in the presence of iron oxide-dextran nanoparticles and iron oxide-dextran thin films were evaluated.

EXPERIMENTAL SECTION

Dextran coated iron oxide thin films (dextran-iron oxide thin film) were obtained by spin coating technique. The iron oxide nanoparticles were synthesized by an adapted co-precipitation method. The samples were characterized for phase content by X-ray diffraction (XRD) with a Bruker D8-Advance X-ray diffractometer in the scanning range 10-60°.The morphology of the material was studied using a HITACHI S2600N-type scanning electron microscope (SEM). The elemental analysis was performed using an energy dispersive spectroscopy (EDS) detector. The top surface analysis of the samples was studied by the Glow Discharge Optical Emission Spectroscopy (GDOES) using the GD5000 from Horiba/Jobin-Yvon. The XPS spectra were measured on a VG ESCA 3 MK II XPS installation.

The biological evaluation of the dextran-iron oxide nanoparticles and dextran-iron oxide thin films was conducted using HepG2 cells. The Hep G2 cells were maintained in DMEM, containing 3,7 g/L sodium bicarbonate, 4,5g/L D-glucose, 4,7g/L 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid (HEPES), 4 mM L-glutamine, 0,1 mM sodium pyruvate, 100 U/ml penicillin, 100 U/ml streptomycin and 10% (v/v) foetal bovine serum. Cells were grown in 5% CO_2 at 37^{o}C. The cells were grown as monolayers in 75 cm^2 cell culture flasks. They were seeded at a density of 2,5x10^5 cells/ml and incubated with the dextran coated iron oxide nanoparticles and dextran-iron oxide 5% thin film. After 24 h, the cells were imaged by a bright field inverted microscope (Olympus IX7). Images were acquired by specific software Cell F using a CCD video camera COLORVIEW.

RESULTS

Diffraction patterns of powders show the peaks that corresponds to a cubic maghemite structure. The structural analysis conducted by XRD showed that the thin films preserved the characteristics of the initial powders.

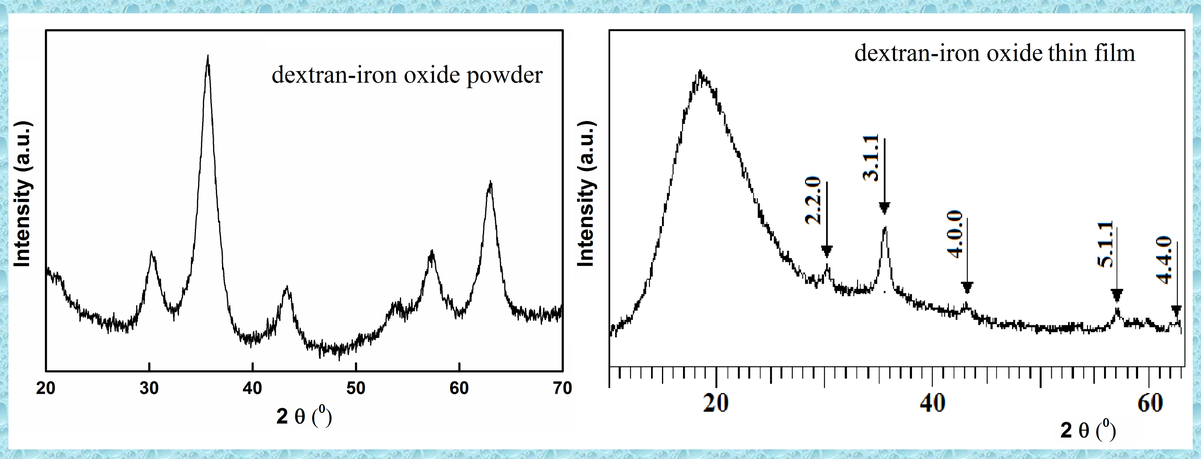

Figure 1: XRD patterns of dextran coated iron oxide nanoparticles and dextran-iron oxide thin film.

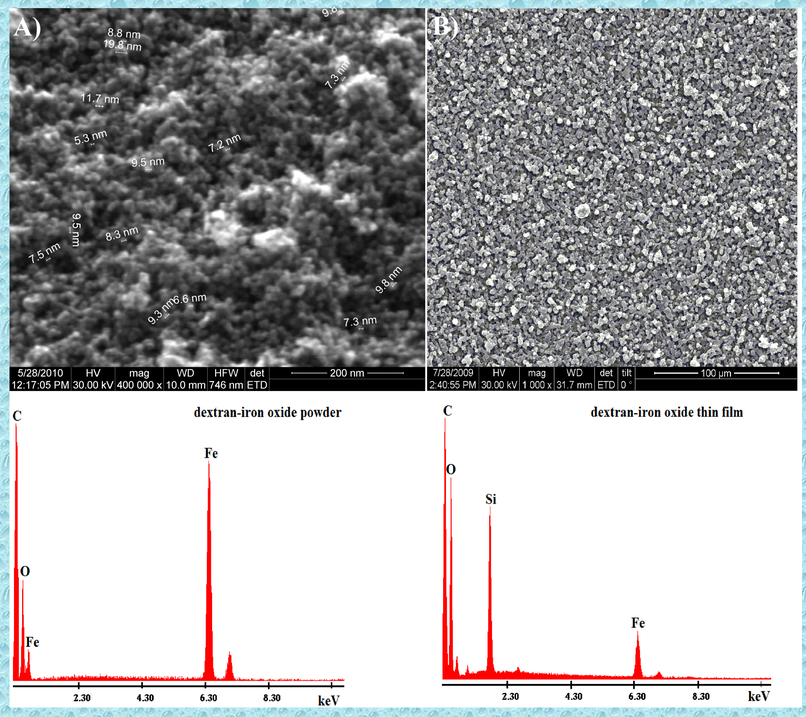

Figure 2: SEM images of dextran-iron oxide powder (A) and dextran-iron oxide thin film (B). EDS spectra of dextran-iron oxide powder and dextran-iron oxide thin film.

The nanoparticles size is around 8 nm. The shape of the particles is spherical.

The presence of only Fe, O, C and Si was observed in the EDS spectra of dextran-iron oxide thin film.

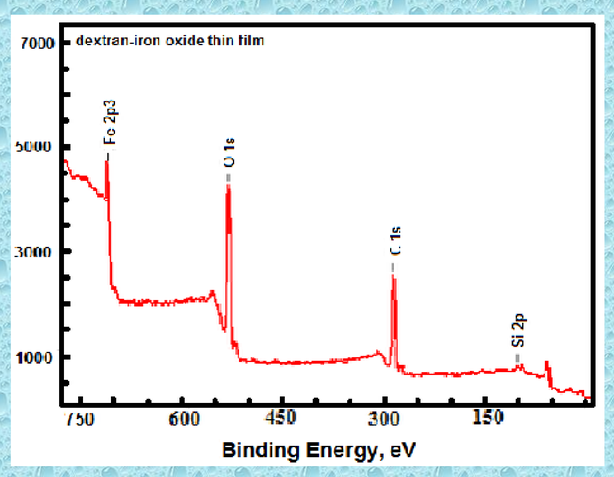

Figure 3: XPS spectra of dextran-iron oxide thin film.

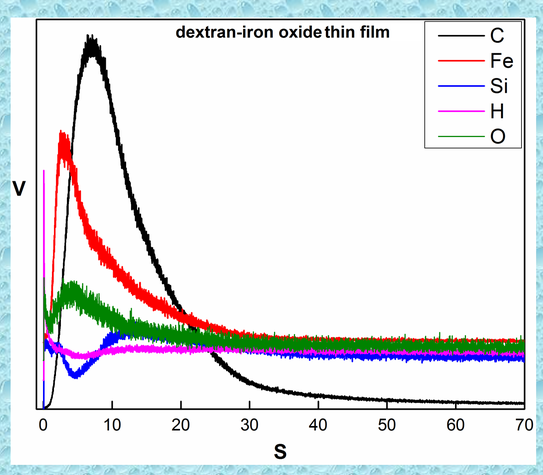

Figure 4: GDOES spectra of dextran-iron oxide thin films.

The XPS and the GDOES spectra revealed the presence of a materials composed mainly of C, O and Fe. The C signal corresponds to dextran, while, Fe is related to maghemite. The presence of oxygen is due to dextran and maghemite.

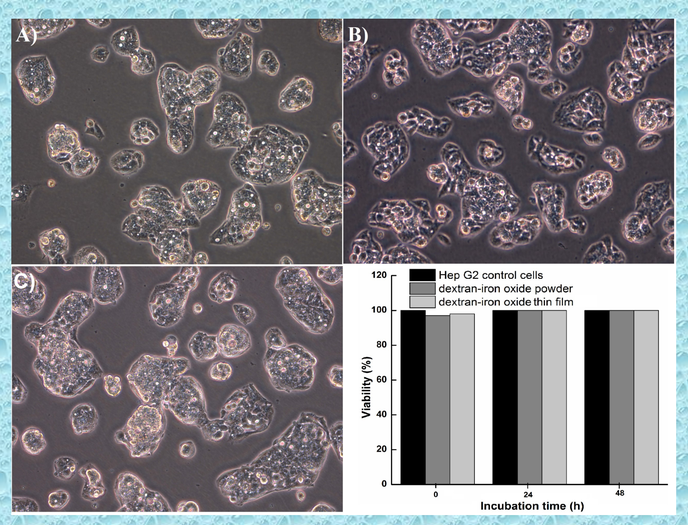

Figure 5: Morphological comparison of HepG2 cells on dextran-iron oxide powders (B) ; dextran-iron oxide thin film (C); control (A) The MTT assay results obtained on control cells, dextran-iron oxide powder and dextran-iron oxide thin film.

The morphology of the HepG2 cells in the presence of dextran-iron oxide powders and dextran-iron oxide thin films was unchanged. The viability of HepG2 cells cultivated in the presence of dextran-iron oxide powders and dextran-iron oxide thin films was good compared to the control at 24 and 48 h .

CONCLUSIONS

In conclusion we can say that the dextran-iron oxide thin films obtained by spin coating technique have good compatibility. The thin films prepared by spin coating present a granular surface and preserved the structure of dextran-iron oxide nanoparticles. A very well adherence of HepG2 cells to dextran-iron oxide thin films was also observed. As a result, our studies provide a base for future discussions on toxicity and potential applications of dextran-iron oxide thin films in the field of biomedicine.

Acknowledgements:
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