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Analysis of a new sunscreen active ingredient based on β-FeTCP nanoparticles

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Abstract – This work had for objective the production of Fe^{3+} -doped calcium phosphate (β-FeTCP) via chemical precipitation route and the physical and chemical analysis of the obtained powders. The results showed the formation of β-FeTCP with nanometer particles, without formation of reactivate species and the Fe^{3+} ion generated optical absorption in the ultraviolet region when incorporate in the β-TCP matrix. This material can be used as an active ingredient for application in sunscreens, especially due to the excellent biocompatibility of β-TCP combined to the optical absorption of Fe^{3+} ion in the β-TCP matrix.

The number of new cases of skin cancer is growing continually in the world, especially in Brazil, where this number is around 120 thousand per year. Sunscreens might be capable to absorb or to reflect the incident UV radiation protecting the individuals [1]. Therefore, there is an urgent need for the development of safer sunscreen system, that can be achieved by formulations using biocompatible materials. The inorganic sunscreens represent one of the best and effective methods to protect the skin due to a low level of skin irritability, thus they are recommended for children and people with sensitive skins.

The biocompatibility of tricalcium phosphate (β-TCP) is a very well known, besides many of its physical properties [2]. Fe^{3+} is a metal that may generates optical absorption bands in the UV range when incorporated in a crystalline matrix. The biocompatibility β-TCP with the optical activity of the Fe^{3+} turn the β-FeTCP very interesting to be investigated as active ingredient for inorganic sunscreens.

Thus, in the present work, β-TCP doped with Fe^{3+} was chemically synthesized by precipitation method of $Ca(NO_3)_2.4H_20$ and $(NH_4)_2HPO_4$ adding the metal in the concentration 0,01M, varying the calcination conditions. The precipitated β-FeTCP powders were characterized using X-ray Diffraction (XRD), Energy Dispersive X-ray (EDX), Atomic Force Microscopy (AFM) and UV-vis spectroscopy (AO). XRD patterns of powders calcined 800 °C to 1000 °C, as shown in Fig. 1, revealed no secondary phases besides β-FeTCP. However, in the sample calcined to 700 °C it was formed the phase FeHAP instead of β-FeTCP. Besides the phases shown in the XRD there was formed calcium oxide (CaO) in all samples identified by EDX. The study of the formation of minority phases is extremely important because the presence of reactive species impedes the application of a material as sunscreen. As CaO is biocompatible its presence would not impede the application of product in the formulation of sunscreens. With AFM it was possible to verify that the produced powder are mainly formed by agglomerates, composed by ellipsoidal nanometric particles, of about 42 nm. Fig. 2 shows that all the samples have intense optical absorption bands in the UV and the temperature calcination with 700 °C, 900 °C and 1000 °C generated absorption in the visible region, altering also the intensity of the absorption bands. With this results, its is possible to conclude that the FeHAP and β-FeTCP, especially β-FeTCP calcined to 800 °C, presented ideals characteristics to be used as active ingredient of sunscreen.

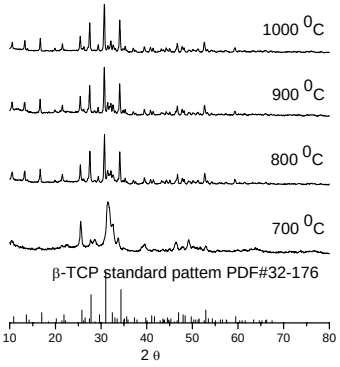

Figure 1: XRD powder patterns of β-FeTCP producted at different calcination temperatures

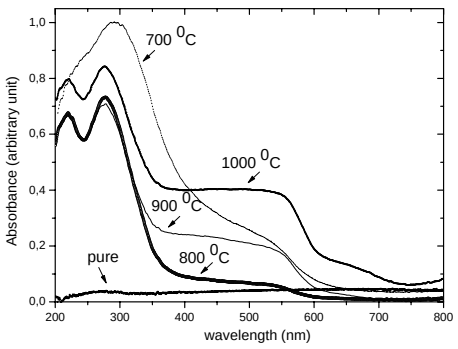

Figure 2: UV–Vis absorption spectra β-FeTCP at different calcination temperatures and β-TCP calcined in 800 °C

[1] T. S. de Araujo, S. O. de Souza Scientia Plena 4, 11 (2008) 1-7
[2] T. S. de Araujo, Z. S. Macedo, P. A. S. C. Oliveira, M. E. G. Valerio Journal of Materials Science 42, 7 (2007) 2236-2243