Dysprosium/Iron Aluminosilicate for Simultaneous Radiotherapy and Hyperthermia: Structural Investigation and Biocompatibility Evaluation

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The proposed materials in the present work are of great interest in the treatment of degenerative diseases by internal radiotherapy and hyperthermia. The sol-gel method chosen for the preparation of the materials allows obtaining materials of high purity and homogeneity at lower temperatures than those used in classical melting method. These biomaterials could be used in internal therapy of cancer, by local irradiation of the malignant tumors, with high energy and short range beta radiation, and in the same time heating them by electromagnetically hyperthermia; the concomitant effect of both therapy methods significantly increases the treatment's efficiency. Structural properties of dysprosium/iron aluminosilicate are investigated in this work by FTIR, Raman and EPR spectroscopy. Vibrational spectroscopy reveals the dominant bands around 1080 cm^{-1} assigned to the stretching vibration of Si-O-Si and Al-O-Al bond, and the Al-O stretching vibrations of tetrahedral AlO_4 groups related with the bands at 796 cm^{-1} (fig.1). The EPR spectra indicate the modifications of the environment of Fe^{3+} ($3d^5$, $^6S_{5/2}$) due to different dysprosium concentration. The use of in vivo radiotherapy is drastically limited by the biocompatibility of the materials incorporating radionuclides, the activity of the radionuclides and the chemical stability of the materials in the biological environment. Radiotherapeutic glasses must be biocompatible, insoluble and have high chemical purity as long as they are radioactive. The biocompatibility was evaluated with respect to collagen and fibrinogen adsorption, by analysing the ATR FTIR spectra (Fig. 1). Deconvolution of amide I absorption band (Fig.2) of both proteins is indicative of conformational changes in the secondary structure upon the adsorption. The results are interpreted by correlating the dysprosium concentration with structural properties of adsorbed proteins.

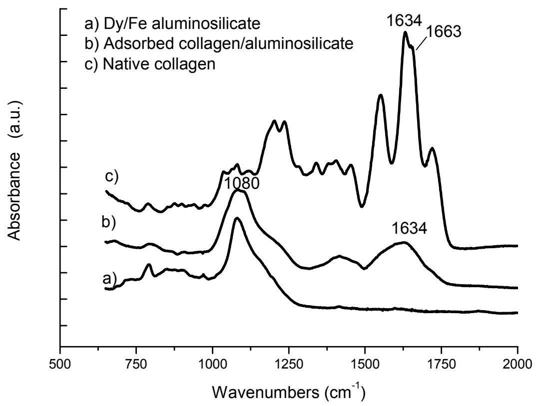

Fig. 1: FTIR spectra of Dy/Fe aluminosilicate.

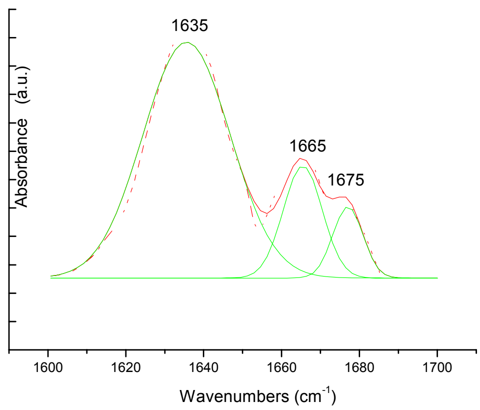

Fig. 2: Deconvolution of amide I band of adsorbed collagen.