A-TYPE APATITE POWDER EPR RESPONSE TO PHOTONS IN THE

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Body of Abstract: Bones and tooth enamel have been applied successfully for dose reconstruction in accidents and archaeological dating using EPR spectroscopy. The method is based on the measurement of radiation-induced carbonate radicals in biological apatites. Carbonate ions are incorporated into hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$) crystalline lattice of the calcified tissues substituting for both phosphate (B-type) and hydroxyl (A-type) ions. Synthetic carbonated apatites are used as model systems for biological apatites and the EPR spectrum of B-type carbonated apatites has been intensively investigated by some authors. However the EPR spectrum of these materials depends considerably on the samples preparation method. In anyway contributions arising from several radicals ($CO_2^{?}$, $CO^{?}$, $CO_3^{?}$, $CO_3^{3?}$, $O^{?}$ etc) overlap producing complex spectra. Only recently the A-type carbonated apatite has been considered as a model system for biological apatites. In this project, the dose response of A- and B-type apatites were compared with each other and the A-type apatites were found to have the highest efficiency to the same absorbed dose with the simplest EPR spectrum. The influence of the synthesis parameters on the properties of the A-type apatite was systematically investigated using X-band and Q-band EPR measurements giving rise to a synthetic material with excellent potential for dosimetric application in the therapy dose level. The material development was also based on the characterization by X-ray diffraction, infrared spectroscopy, induced couple plasma and multiphase carbon analyzer with infrared detector. Reproducibility of several dosimetric material batches demonstrated a carefully controlled production process. The response of A-type apatite powder dosimeter to ^{60}Co gamma rays source and high-energy photon beams of 6, 15 and 18 MV produced by medical accelerators is discussed. Low energy dependence was verified for samples irradiated in terms of absorbed-dose-to-water with high-energy photons. Temperature dependence up to 100^{o}C and humidity influence on the dose signal were not observed after annealing of unstable signals and no fading was recorded in at least two years, although the dose record has maintained for six years. Intrinsic uncertainty sources to the dosimeter and the EPR technique in the interest range were analyzed without any numerical signal treatment. The overall uncertainty was less than 2% at 95% confidence level for samples irradiated to 2 Gy. Uncertainties can be still reduced filtering simultaneously background (cavity) and noise in the frequency domain of EPR spectra and using the latest spectrometers. Detection threshold of 0.2 Gy can be easily reached with Bruker spectrometers non-updated. Dose saturation was observed above 3 kGy and linear functions can be fitted in the therapeutic dose range. Results revealed that the A-type apatite/EPR dosimetry system present excellent characteristics for application in radiotherapy.