Thesis Abstract

Thesis title : Electron paramagnetic resonance dosimetry : methodology and material characterization
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Electron Paramagnetic Resonance (EPR) methodologies for radiation dose reconstruction are investigated using various dosimeter materials. Specifically, methodologies were developed and used that were intended to improve the accuracy and precision of EPR dosimetric techniques, including combining specimen rotation during measurement, use of an internal manganese standard, instrument stabilization techniques and strict measurement protocols. Characterization and quantification of these improvements were preformed on three specific EPR dosimeter materials. The dosimeter materials investigated using these optimized EPR techniques were Walrus teeth, human tooth enamel and alanine dosimeters. Walrus teeth showed the least desirable properties for EPR dosimetry yielding large native signals and low sensitivity (EPR signal per unit dose). The method for tooth enamel and alanine resulted in large improvements in precision and accuracy. The minimum detectable dose (MDD) found for alanine was approximately 30 mGy (three standard deviations from the measured zero dose value). This is a sensitivity improvement of 5 to 10 over other specialized techniques published in the literature that offer MDD's in the range of 150 mGy to 300 mGy. The accuracy of the method on tooth enamel was comparable to that typically reported in the literature although the measurement precision was increased by about 7. This improvement in measurement precision enables various applications including dose vs. depth profile analysis and a more non destructive testing evaluation (where the whole sample need not be additively irradiated in order to calibrate its radiation response). A non destructive evaluation of numerous samples showed that the method could reconstruct the same doses to within 10 mGy of those evaluated destructively. Doses used for this assessment were in the range of 100 to 250 mGy. The method had sufficient stability to measure tooth enamel samples exhibiting extreme anisotropy with a precision of approximately 5%. This is a significant improvement since the dosimetric EPR signal from a single tooth enamel grain may vary by as much as 50% depending on its orientation in the cavity.

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