A ^{13}C and ^{1}H NMR study of the mechanism of T_2 relaxation in radiation dosimetry gels

Polymer gels containing water, acrylamide, N,N'-methylene-bisacrylamide (BIS) and gelatin are used in radiation dosimetry. We have used ^{13}C and ^{1}H nuclear magnetic resonance (NMR) spectroscopy to investigate the changes in gel structure and rates of relaxation upon irradiation to doses in the range 0 - 50 Gy. The spin-spin relaxation time constants (T_2) of water protons in these gels change systematically as a function of locally absorbed radiation dose. The change may be correlated with the nature and the amount of local radiation-induced cross-linking and/or degradation in the gels that will both modify the water chemical environment. Our results confirm FT-Raman spectra[1] showing an exponential decay for the spectroscopic signature of both acrylamide and BIS with increasing absorbed dose. Cross polarization experiments show an initial contribution of the monomers resulting from their relative immobilisation by the gelatin network. After irradiation to 30 Gy, the cross polarization occurs primarily to the rigid amide polymer network. The individual role of acrylamide, BIS and gelatin diluted in deuterated water was investigated. The T_2 relaxation time of gelatin in deuterium oxide contains at least two components of 8 and 97 ms. After irradiation to 30 Gy, the time constants become 8 and 56 ms. Measurements of both relaxation times and hence the fundamental relaxation times of polymer surface and water were investigated as a function of the D_2O / H_2O ratio.

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[1] C. Baldock, L. Rintoul, S. F. Keevil, J. M. Pope and G. A. George, Phys. Med. Biol. **43**, 3617 (1998)