Development and initial characterization of a nuclear magnetic resonance dosimetry system

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A novel high dose radiation dosimeter was developed employing NMR spectroscopic quantitation of the radiolytic products of methanol. Chemical shifts of product resonances relative to the solvent allow quantification using NMR techniques. Due to expected dynamic range limitations of NMR instrumentation, deuterated methanol is used with a presaturation suppression sequence to reduce the solvent proton signals. Methanol's $\sp{13}C$-coupled proton resonance is used as an internal reference to normalize product signals otherwise subject to spectrometer variability. Data on reproducibility, dose response, and temporal stability were acquired. System reproducibility for a sample at 1 kGy is $\approx$10%. The dose response is linear in the range between 200 Gy and 50 kGy. No significant signal degradation was observed during a six month period. Advantages of this type dosimeter system include ease of use, large dynamic range, and temporal stability. An additional characteristic of a methanol based system is the LET dependent response in the chemical yields of formaldehyde and ethylene glycol.