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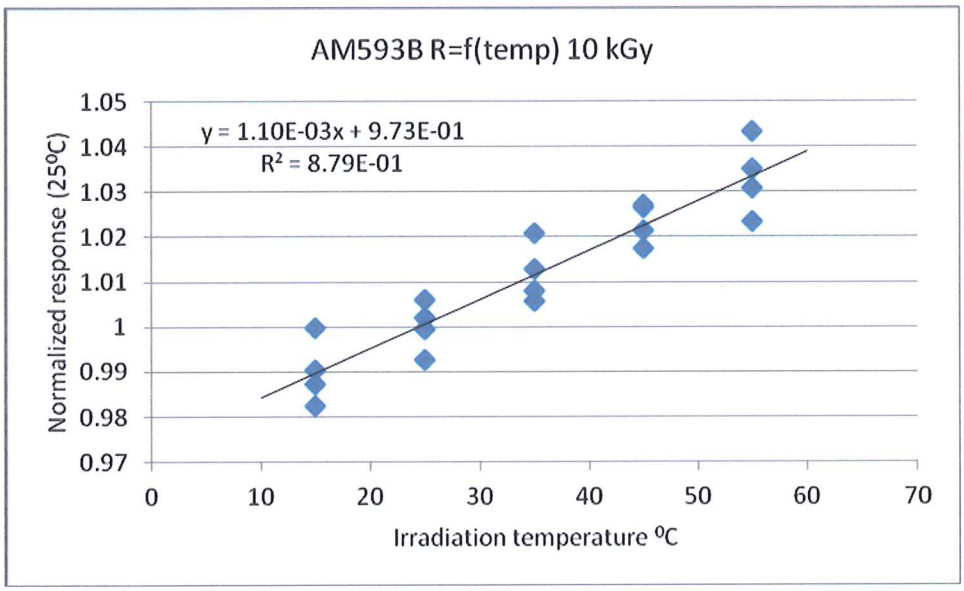
Risø High Dose Reference Laboratory – Risø HDRL

Technical note 02

Alanine dosimeters – Correction of response for irradiation temperature.

The response of alanine dosimeters depend on the temperature during irradiation. Calibration of Risø HDRL alanine reference dosimeters is carried out by irradiation at the Risø Gamma cell at an irradiation temperature of 25^{0}C. The temperature coefficient C is measured for each new batch of alanine dosimeters by irradiation in the Risø Gamma cell over a range of irradiation temperatures, see example in the figure, where the temperature coefficient is determined to be 0.11 % $^0C^{-1}$.



The temperature coefficient C has been found to be almost constant up to approximately 50 kGy, but at greater doses the temperature coefficient has been found to increase by as much as 50% at 100 kGy (Sharpe et al, 2011).

Gamma irradiation

The temperature of the alanine dosimeter will increase during irradiation at an industrial irradiation facility. At gamma facilities the temperature rise is a complex function as the dosimeter passes the gamma source a number of times during a complete cycle. It has been shown that the effective irradiation temperature T_{eff} can be approximated by:

$$T_{eff} = T_{start} + (T_{end} - T_{start})*2/3 \qquad \text{(Sharpe et al, 2000).}$$

Correction of the response of the alanine dosimeter irradiated at gamma is then carried out as:

$$R_{25} = R(T_{eff}) * (1 + C*(25 - T_{eff}))$$

$R(T_{eff})$ = Response for irradiation at T_{eff}
$R(25)$ = Response for irradiation at 25^0C

Electron irradiation

During irradiation at electron accelerators the temperature of the alanine dosimeter increases almost linearly due to the short irradiation time, and the effective irradiation temperature T_{eff} is therefore equal to the average temperature and can be calculated as:

$$T_{eff} = (T_{start} + T_{end})/2$$

The response of alanine dosimeters irradiated at electron accelerators has traditionally been corrected for the effective irradiation temperature T_{eff}, see e.g. Sharpe and Miller (2009). However, evidence has been gathering that this might not be correct. For industrial electron beam irradiations, data from both primary calorimetric methods and machine output measurements indicate a significantly better correlation with alanine dosimetry, if the alanine is corrected to maximum irradiation temperature T_{end}, rather than effective irradiation temperature (Sharpe et al, 2011).

We therefore recommended that dose measurements with alanine reference dosimeters are corrected for the maximum irradiation temperature, T_{end}:

$$R_{25} = R(T_{end}) * (1 + C*(25 - T_{end}))$$

Certificates

Results for measurements with alanine reference dosimeters are given in Risø HDRL certificates as corrected for effective irradiation temperature T_{eff} and corrected for maximum irradiation temperature T_{end}.

References:

Sharpe, P.H.G. and Miller A. (2009) "Guidelines for the Calibration of Routine Dosimetry Systems for use in Radiation Processing." CIRM-29, National Physical Laboratory, Teddington, TW11 0LW, United Kingdom

Sharpe, P.H.G., Miller, A., Lundahl, B., Kuntz, F., Pageau, G. (2011) "Correction for the Effect of Irradiation Temperature on the Response of Alanine Dosimeters in Industrial Electron Beams. Poster presented at IMRP-2011, Montreal, Canada. Article to be submitted to Rad Phys Chem. (Draft attached to this technical note).

Sharpe, P.H.G., Sephton, J.P., and Chu, R.D. (2000). "Real time dosimetry measurements at an industrial irradiation plant," *Radiat. Phys. Chem.* **57**, 687–690.

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