Supplementary Information for

Spiropyran-based X-ray sensitive fiber

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Experimental

The Fricke solution was prepared with 112 mg of iron(II) sulfate heptahydrate (Wako Pure Chemical Industry, Ltd.), and 8.26 g of concentrated sulfuric acid diluted in aerated distilled water (corresponding to 0.4 M H_2SO_4 aqueous solution).

The Fricke solution was placed on the same position so that the irradiation conditions were equivalent to the 6-nitro BIPS-dyed composite fiber. The measurement of absorbance was performed using a spectrophotometer (Perkin-Elmer Co., Lambda 1050UV/Vis/NIR). The change in optical density measured with a spectrophotometer with good optical properties is equal to the change in absorbance. The absorbed dose to the Fricke solution D_F is obtained from the change in absorbance ΔA as:

$$D_F = \frac{\Delta A}{\rho \ell \varepsilon G(Fe^{3+})},$$

where ΔA is the change in absorbance at 304 nm, ρ is the density of the Fricke solution, ℓ is the optical pathlength, ε is the molar extinction coefficient of Fe^{3+}, and G (Fe^{3+}) is the Fe^{3+} ion yield. The absorbed dose to water D_w is obtained as

$$D_W = 1.004 D_F .$$

For the Fricke solution, we use the values of 1 cm for ℓ, 1.023×10^6 g m^{-3} for ρ, 2196 M^{-1} cm^{-1} for ε, and 15.5 for G (Fe^{3+}), and a product of εG (Fe^{3+}) = 3.4 m^2 g^{-1} Gy^{-1}, the expressions reduce to

$$D_W = 278 \Delta A .$$

It has been reported that G (Fe^{3+}) at around 25 °C decreases by 0.12% for a 1°C decrease in the irradiation temperature T_{irrad}, and ε decreases by 0.69% for a 1°C decrease in the reading temperature T_{read}. Accordingly, the absorbed dose can be corrected more accurately by using the above relationships.[S1,S2] The compensation equation is eventually expressed as follows:

$$D_W = 278 \Delta A [(1 + 0.0069(25 - T_{read}) \times (1 + 0.00125(25 - T_{irrad})] .$$

Figure S1 shows absorption spectra of the Fricke solution before and after X-ray exposure. The absorption intensities at 304 nm before and after X-ray exposure show 0.017 and 0.043, respectively. The experiments were conducted at 19 °C, and the absorbed dose from an X-ray diffractometer (Rigaku ZSX Primus II, Japan) was accordingly estimated to be 7.41 Gy.

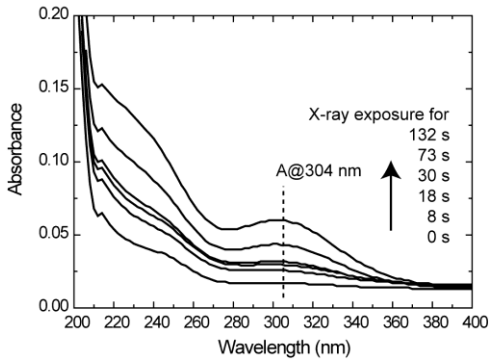

Figure S1. Absorption spectra of the Fricke solution before and after X-ray exposure.

REFERENCES

[S1] IRS (2002), A. Olszanski, A., Klassen, N. V., Ross C. K., and Shortt, K. R., "The IRS Fricke Dosimetry System", Ionizing Radiation Standards, Institute for National Measurement Standards, National Research Council, PIRS- 0815, Ottawa, Ontario.

[S2] International Atomic Energy Agency (1977) "Manual of Food Irradiation Dosimetry", TRS 178, IAEA, Vienna.