Supplementary Information for
Spiropyran-based X-ray sensitive fiber

Kenji Kinashi a*, Yurika Miyamae a, Ryotaro Nakamura a, Wataru Sakai a, Naoto Tsutsumi a, Hideki Yamane b, Gaku Hatsuikano b, Makoto Ozaki c, Kazuya Jimbo d, Takahiro Okabe d.

a Department of Macromolecular Science and Engineering, Graduate School of Science and Technology, Kyoto Institute of Technology, Matsugasaki, Sakyo, Kyoto 606-8585, Japan

b Department of Biobased Materials Science, Graduate School of Science and Technology, Kyoto Institute of Technology, Matsugasaki, Sakyo, Kyoto 606-8585, Japan

c Advanced Technology Center, Kyoto Institute of Technology, Matsugasaki, Sakyo, Kyoto 606-8585, Japan

d NISSHA PRINTING CO., LTD, 3 Mibu, Hanai, Nakagyo, Kyoto 604-8551 Japan

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 H₂SO₄ 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 $\Delta A$ as:

$$D_F = \frac{\Delta A}{\rho \varepsilon G(Fe^{3+})},$$
where $\Delta A$ is the change in absorbance at 304 nm, $\rho$ is the density of the Fricke solution, $\ell$ is the optical pathlength, $\varepsilon$ is the molar extinction coefficient of $\text{Fe}^{3+}$, and $G$ ($\text{Fe}^{3+}$) is the $\text{Fe}^{3+}$ 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 $\ell$, $1.023 \times 10^6 \text{ g m}^{-3}$ for $\rho$, 2196 M$^{-1}$ cm$^{-1}$ for $\varepsilon$, and 15.5 for $G$ ($\text{Fe}^{3+}$), and a product of $\varepsilon G$ ($\text{Fe}^{3+}$) = 3.4 m$^2$ g$^{-1}$ Gy$^{-1}$, the expressions reduce to

$$D_w = 278 \Delta A .$$

It has been reported that $G$ ($\text{Fe}^{3+}$) at around 25 °C decreases by 0.12% for a 1°C decrease in the irradiation temperature $T_{irrad}$, and $\varepsilon$ 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.\textsuperscript{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.

![Absorption spectra](image)

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

**REFERENCES**
