

Optimum wavelength of ultraviolet rays in Gafchromic EBT2

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Introduction

- To determine the optimal **UV-A** wavelength using a **UV-LED**.
- Gafchromic film is used for QA, QC, and radiation dose measurement.
- Gafchromic EBT is designed for the measurement of absorbed doses of X-rays
- **UV-A** rays was used rather than X-rays.
- **UV-LED** at a wavelength from 353 to 400 nm were used.
- Back side of Gafchromic EBT2 is protected from UV irradiation.
- The reaction of the active layer is observed.

Materials & Methods 1

- **UV-LED** that UV rays at a wavelength from 353 nm to 400 nm (Nitride Semiconductors Co., Ltd., Tokushima) were used (Fig. 1.)

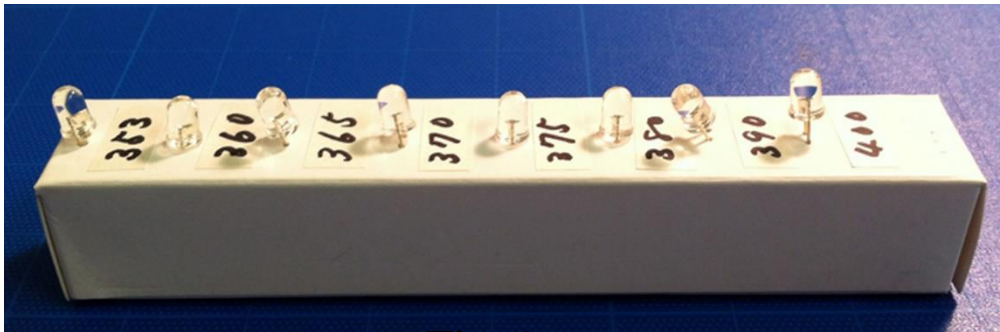


Fig. 1.

- Gafchromic EBT2 (lot #02171403; Ashland, Inc., Covington, KY) (expiry date February 2016) was cut into 10.2 cm × 25.4 cm.

Materials & Methods 2

- **Irradiation device:** Fixing the irradiation position contained 20 holes with 30 mm diameters(Fig. 2). (Comogras CG UV40 P, 3 mm thickness, lot # 140406C B; Kuraray Co., Ltd., Tokyo)
- The **UV-LEDs** were attached acrylic box (Fig. 3).
- Placements of the measurement are shown in Fig. 4.

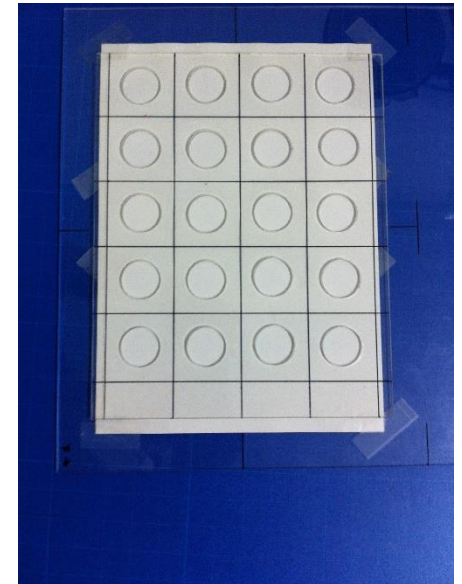


Fig. 2.

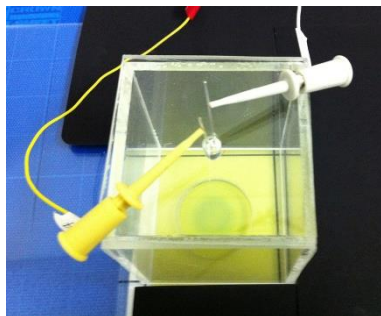


Fig. 3.

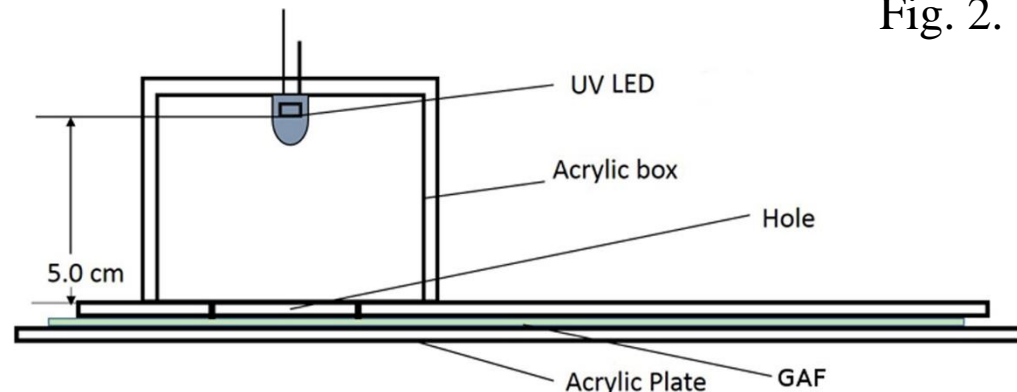


Fig. 4.

Materials & Methods 3

- **Irradiation method:** EBT2 was irradiated **UV-A** for 60 min (10 W UV fluorescent lamp). Next, it was irradiated an hole for 60 min in distance from 5.3 cm using V-A LED.
- **Scanning method:** Scanning was performed with (EPSON ES-10000G; Seiko Epson Corporation, Nagano) Adobe Photoshop CS2 (Adobe Systems Inc., San Jose, CA) at 48 bits, 100 dpi with PPC film (CR-PP686; 3M Company, St. Paul, MN) and a protective film of liquid crystal (LCD-230W; Sanwa Supply Inc., Okayama) .
 - **Analysis:** A circular region of interest (ROI) of 0.5-inch diameter was set (Fig. 5a and b). The Image J (National Institutes of Health, Bethesda, MD). The maximum, minimum, and mean \pm standard deviation (SD) of pixel value were evaluated.

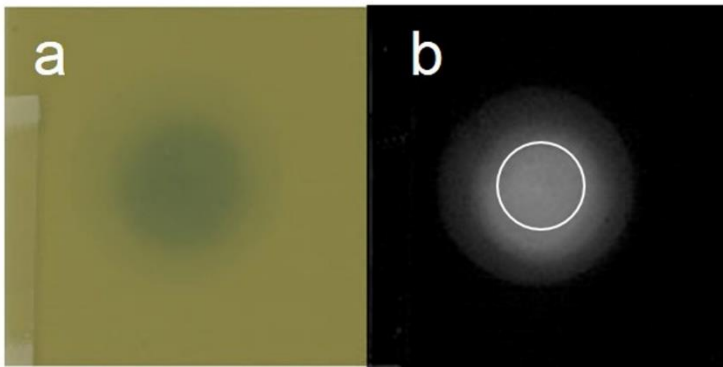


Fig. 5.

Result

- A graph of Gafchromic EBT2 (375 nm) (Fig. 6).
- Pixel values were 12,005, 6,972, and 8,915.25 ± 608.86, respectively (Table 2).

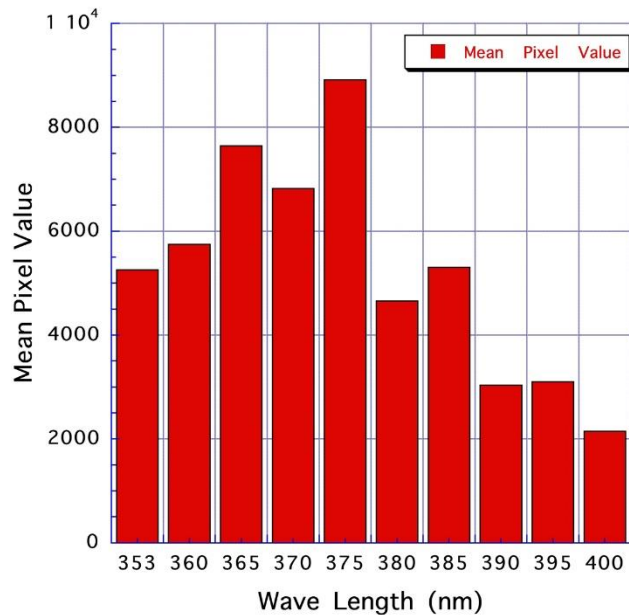


Fig. 6.

Table 2. Pixel number of subtracted Gafchromic EBT2 at each UV wavelength

λ_p (nm)	Pixel number		
	Max	Min	Mean ± SD
353	9035	0	5255.18 ± 655.41
360	6889	4777	5746.91 ± 326.72
365	9131	5853	7642.90 ± 546.88
370	8501	5069	6824.28 ± 378.18
375	12005	6972	8915.25 ± 608.86
380	5925	2933	4653.39 ± 430.81
385	7001	3393	5300.75 ± 511.43
390	4053	1877	3035.42 ± 279.83
395	4937	539	3100.12 ± 319.62
400	3697	952	2149.11 ± 261.96

λ_p (nm): Peak wavelength

Discussion 1

- **4.1. UV-LED and UV wavelength**
- The cannonball-shaped **UV-LEDs** that UV wavelength from 353 to 400 nm were the most suitable for this study.
- A **UV-LED** wavelength of 375 nm was indicated the maximum pixel values on Gafchromic EBT2 in this study.
- This result found a **UV-LED** is superior than UV fluorescent lamp to irradiation of UV ray to Gafchromic EBT2.

Discussion 2

- **4.2. UV protection for humans**
- In this study, the **UV-A** wavelengths varied from 353 nm to 400 nm.
- A UV irradiation box was constructed using an UV cut acrylic board to prevent any leakage from the box.

Discussion 3

- **4.3. Future study**
- Although the most suitable irradiation wavelength is 375 nm, however, strength to the Gafchromic EBT2 is unclear. Thus, it will be necessary to determine the most suitable irradiation strength or duration.

Conclusion

- Gafchromic EBT2 reacted most effectively to UV-A LED at 375 nm.
- **UV-A** is used to correction of nonuniformity error of Gafchromic EBT2.
- It is a substitute for X-rays in the double exposure technique.
- 375 nm wavelength of **UV-LED** should be used.