# Performance optimization on the sensitivity and uniformity of the LiPCDA film

Jin Dong Cho[1,2,3], Jaeman Son[1,3,4], Jin Hyuck Kim[1,3], Bitbyeol Kim[1,3], Euntaek Yoon[1,3], Jinsung Kim[2], Hong-Gyun Wu[1,3,4,5,6], Chang Heon Choi[1,3,4], Jong Min Park[1,3,4,5], Jung-in Kim[1,3,4], and Seongmoon Jung[1,3,4*]

[1]Department of Radiation Oncology, Seoul National University Hospital, Seoul, Korea
[2]Department of Radiation Oncology, Yonsei University College of Medicine, Seoul, Korea
[3]Biomedical Research Institute, Seoul National University Hospital, Seoul, Korea
[4]Institute of Radiation Medicine, Seoul National University Medical Research Center, Seoul, Korea
[5]Department of Radiation Oncology, Seoul National University College of Medicine, Seoul, Korea
[6]Cancer Research Institute Seoul National University College of Medicine, Seoul, Korea

**Background:** Lithium salts of pentacosa -10,12-diionic acid (LiPCDA) films which are the active layer material of the recently developed in vivo dosimeters, contact lens-type ocular in vivo dosimeter (CLOD) and a flexible film dosimeter, are required to high sensitivity and uniformity to achieve optimal dosimeter performance. When performing in-vivo dosimetry of CLOD and flexible film dosimeter, it is attached to a site with a high dose gradient, and a low dose out of field irradiated to the target was measured. Therefore, in order to measure the low dose of out of field and the accurate dose in the site of the steep dose gradient where the dose changes rapidly, a dosimeter with high sensitivity was needed. However, although these dosimeters have advantages that can be worn directly on the eye and be more flexible than EBT3 film, in-house LiPCDA shows 15% lower sensitivity than EBT3 film. The purpose of this study is to improve the sensitivity and uniformity by changing the concentration of pentacosa-10, 12-diynoic acid (PCDA) and manufacturing procedures.

**Methods:** The LiPCDA was composed of the PCDA, tetraethylammonium hydroxide (TEAH), lithium acetate, and water. The LiPCDA was produced by adding Lithium acetate after manufacturing procedures of filtering a solution of the PCDA, TEAH, and water. The LiPCDA films were fabricated with three groups according to the concentration of composition and manufacturing procedures in the study. The first group increased the concentration of the PCDA by 0% (reference film), 25%, 35%, and 45%. The second group was produced with/ without a ball mill in order to reduce the PCDA to a uniform size. The 8-12 μm filter was used to manufacturing procedures in reference film and both groups. Finally, the third group was fabricated by using a filter with 3-5 μm, 8-12 μm and 20-25 μm, and none-filter. The film samples were irradiated with doses from 0.2 to 3 Gy using 6 MV photon beams. After irradiation, the pixel values (PVs) of films were acquired with Epson 10000XL flatbed scanner and optical densities were calculated to obtain a dose response curve and to compare the sensitivity of films. The sensitivity of each group was analyzed.

**Results:** The film added the PCDA by 35% has the highest sensitivity for all films, which increased by 62.1% in 1 Gy than reference film. The film with the ball mill had the sensitivity increase of 9.6% compared to film without the ball mill. In the third group, the sensitivity was increased with the filter's size.

**Conclusions**: This study was conducted by the concentration of PCDA, the filter size and with/without the ball mill. The none-filter turned out to be most adequate and the sensitivity of LiPCDA film could be increased by adding 35% PCDA and using a ball mill.

## Reference


1) Devic S. Radiochromic film dosimetry: past, present, and future. Phys Med. 2011;27(3):122-134.

2) Fuss M, Sturtewagen E, De Wagter C, Georg D. Dosimetric characterization of GafChromic EBT film and its implication on film dosimetry quality assurance. Phys Med Biol. 2007;52(14):4211-4225.

3) Andres C, del Castillo A, Tortosa R, Alonso D, Barquero R. A comprehensive study of the Gafchromic EBT2 radiochromic film. A comparison with EBT. Med Phys. 2010;37(12):6271-6278.

4) Kim JI, Cho JD, Son J, Choi CH, Wu HG, Park JM. Contact lens-type ocular in vivo dosimeter for radiotherapy. Med Phys. 2019.

5) Cho JD, Son J, Sung J, et al. Flexible film dosimeter for in vivo dosimetry. Med Phys. 2020;47(7):3204-3213.

6) Papaconstadopoulos P, Hegyi G, Seuntjens J, Devic S. A protocol for EBT3 radiochromic film dosimetry using reflection scanning. Med Phys. 2014;41(12):122101.

7) Ohuchi H. High sensitivity radiochromic film dosimetry using an optical common-mode rejection and a reflective-mode flatbed color scanner. Med Phys. 2007;34(11):4207-4212.

8) Devic S, Seuntjens J, Hegyi G, et al. Dosimetric properties of improved GafChromic films for seven different digitizers. Med Phys. 2004;31(9):2392-2401.