Development of flexible amorphous silicon thin-film solar cell-based real time dosimetry system for therapeutic X-ray

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Purpose: To describe a flexible amorphous silicon thin film solar cell combined with scintillator screen to measure dose of therapeutic X-ray in real time, and to evaluate the dosimetric characteristics of this system and its feasibility for clinical use.

Materials and Methods: The dosimetry system, consisting of a flexible amorphous silicon thin film solar cell and scintillator screen, was connected to electrometer to measure the electric charge generated in the solar cell in real time. First, the dosimetric characteristics such as dose linearity, reproducibility and angular dependency of developed system was evaluated. To convert the measured charge into a dose, calibration factor was obtained by comparing the signals measured using ionization chamber and solar cell dosimetry system. Then, the final dose was obtained by applying correction factors (PDD correction, dose-rate correction, SSD correction, field size correction). Finally, clinical application of developed system was evaluated by measuring 10 treatment fields and comparing the doses calculated by the treatment planning system.

Results: The signals measured by the developed system increased linearly with dose. The dose reproducibility for one month was evaluated to be within 1%. Due to the asymmetric structure of the solar cell, the measured signals were different depending on the incident angle of the beam. Compared with the measurement using ionization chamber, the signals measured using the developed system increased as the measuring depth increased, the dose-rate decreased, the SSD increased, and the field size increased. It was evaluated that difference between ion chamber and developed system was caused by the scintillator screen. When the dose of treatment beam was measured with the developed system and compared with the dose calculated by treatment planning system, it was confirmed that it can be measured within 3%.

Conclusions: It was verified that the system developed through several corrections can be applied clinically for therapeutic X-rays. This system is advantageous for low dose measurement because it uses a scintillator screen to increase the solar cell's measurement efficiency. In addition, the system can be constructed inexpensively and is flexible, so it will be suitable for use on a curved surface or as an in vivo dosimetry tool by placing it on a patient's surface.

Keywords: Flexible thin film solar cell, Scintillator screen, Real time dosimetry