Mammography X rays dosimetry using epitaxial silicon diodes

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Introduction: It is quite feasible that thin silicon diodes based on epitaxial (EPI) technology [1,2] can be applied in on-line X rays dosimetry without the drawbacks of significant energy dependence and current sensitivity drop with the accumulated dose. Indeed, thin depletion region and negligible entrance dead layer are the uttermost characteristics of epitaxial devices for detection of low-energy photons. In this context, studies about the response of a n-type epitaxial (EPI) diode [3] in mammography X rays dosimetry have been carried out and the results so far obtained are presented in this work.

Experimental: The diode used was processed on n-type 75 µm thick epitaxial silicon layer grown on a highly doped n-type 300 µm thick Czochralski (Cz) silicon substrate. This device (25 mm^2 active area) was housed in a polymethylmethacrylate (PMMA) probe with a 0.1 mm thick window and connected to a Keithley 6517B electrometer in the photovoltaic mode. The main dosimetric parameters of the EPI sample were evaluated for mammography X ray beams of 28 kV (RQR-2M) and 35 kV (RQR-4M) from a constant potential X ray system Pantak/Seifert. Irradiations were carried out with the diode positioned at a distance of 1m from the X ray tube and aligned with the center of photon beam (field size of 12 cm diameter).

Results and Discussion: The current signals of the EPI diode irradiated with both X ray energy beams were stable, exhibiting coefficients of variation not superior to 0.1%. It was also evinced that the current increased linearly with dose rate within the range of 2.6 to 38.4 mGy/min for RQR-2M and RQR-4M beams. The charge-dose response is depicted in Fig. 1, characterized by a charge sensitivity of 10.2 nC/mGy. Fig.2 presents the charge sensitivity as function dose rate in the range studied. From both figures non significant energy nor dose rate dependence were observed. Angular dependence was negligible within an angle range of ± 45º. Once the X ray beams were previoulsy calibrated by a Radcal RC6M ionization chamber, the calibration coefficient of the diode, in terms of the air kerma, was also determined. Studies about reproducibility are under way.

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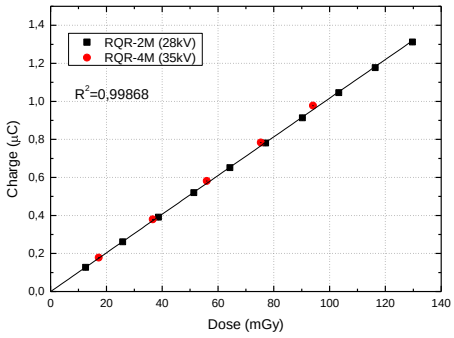

Fig. 1 - Charge-dose response for 28 and 35 kV X rays beams at 13 and 19,2 mGy/min dose rates, respectively.

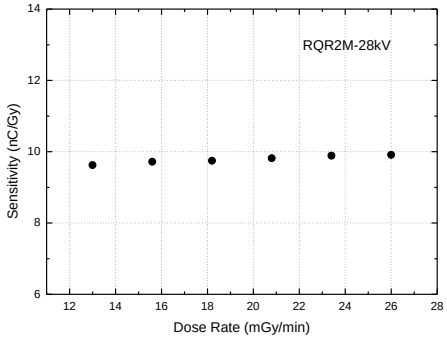

Fig. 2 – Sensitivity of the EPI diode as a function of dose rate for RQR-2M beam.

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