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Development and Evaluation of Parylene C-type Additive detector for High Resolution in High Energy X-ray CT

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Development and Evaluation of Parylene C-type Additive detector for High Resolution in High Energy X-ray CT

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For the high-energy fan beam CT scanning applied to nondestructive inspections on heavy equipment, the one dimensional line detector that maximizes the shield of radiation scattering is used. This, while increasing the image quality, is notified to consume a great deal of time for using a large scaled scan feature on a limited radiation area causing issues of activation due to the irradiation for a long period of time. Therefore, for the industrial nondestructive inspections, the necessity of the high-energy cone beam CT scanning that is available for validation on large amount of component is emerging and researches on the large-area two dimensional detector for the image are actively performed. Currently, researches on detectors of indirect detection based on detection material of CdWO_4 are actively performed for such applications while Si-Diode is utilized for the circuit board to receive the produced radiation. However, the diode shows mechanical vulnerabilities so that the issue of performance change due to the radiation damage has been notified. Therefore, researches on photoconductors for direct detection are actively performed to replace the diodes. On the other hands, among photoconductors, HgI_2 shows relatively higher actual atomic no (Z_eff : 186) and electronic density so that researches on this material for highenergy X ray detections are actively performed. However, HgI_2 has issues that the leakage current exponentially increases following the increase of applied voltage producing unstable factors to implement high-resolution images. In the meanwhile, researches on parylene C layer as an insulating material have been conducted to improve the performance and the drive stability of FET structure in the semiconductor field.^[2] The chemical activity is low and the pinhole-free coating is available so that the evaporation characteristic with a low concentration of charge trap is identified. Therefore, this study aims to make improvements for issue of the unstable leakage current by using the parylene C on the HgI_2 based sensor as the basic work to produce a high resolution large-area detector and to evaluate the response characteristics of parylene C on the evaporation thickness. The sensor is produced in the size of 1 x 1 cm^2 with the thickness of 150 μm considering the dielectric breakdown when the driving voltage of 1 V/μm is applied. Then, using the CVD evaporation method, Parylene C is applied in the thickness of 10 to 20 μm on the photoconductor. The reproducibility and the linearity of the produced sensor are evaluated with the photon energies of 2 MeV and 5 MeV and the Photo/Dark current ratios are presented to evaluate the resolution. For the reproducibility, with the dose rate of 5 Gy/min, the radiation dose of 1 Gy is applied 10 times repeatedly and the evaluation is performed by calculating the standard error(SE) based on the confidence interval of 95%. Also, for the linearity, the radiation doses of 0.001 to 1 Gy with the dose rates of 1 to 5 Gy/min are applied and the evaluation is performed based on the determination coefficient(R-sq) acquired from the linear regression analysis. The experiment results show that the reproducibility of non-parylene with 2 MeV and 5 MeV are 1.20% and 0.94% to be in the confidence interval of 1.5%. On the other hands, the

Parylene applied in the thickness of 18 μm shows the reproducibility of 1.01% and 0.72% respectively with 2 MeV and 5 MeV remarking improvements against the non-parylene case. In case of the linearity, R-sq value of the nonparylene shows to be 0.9931 and 0.9855 respectively with 2 MeV and 5 MeV. And, the 18 μm parylene showing the best reproducibility also shows relatively excellent linearity with 0.9984 and 0.9993. Also, the 18 μm parylene shows improvements of photo/dark current ratio by 5.4%p and 7.1%p respectively with 2 MeV and 5 MeV against that of the non-parylene. This study results are considered to be applicable as basic data to develop a highresolution image detector using parylene C for the insulation as well as for the sensor areas showing various detection structures.

[1] N. Uhlmann et al., Metrology, *Applications and Methods with High Energy CT Systems*, 2014 ResearchGate.
[2] Jan Jakabovic et al., *Preparation and properties of thin parylene layers as the gate dielectric for organic field effect transistor*, Microelectronics Journal 40, 3

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