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Feasibility study of direct-conversion radiation detector using cadmium zinc telluride

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The ultimate object of this paper is to develop direct conversion radiation detector based on Cd(Zn)Te. A polycrystalline Cd(Zn)Te film was deposited using vacuum thermal evaporation technique as fundamental study of large area film fabrication and then investigated the effect on radiation detection characteristics through physical and electrical measurement. First, the composition and structural morphology of deposited Cd_{1-x}Zn_xTe was investigated using EPMA, XRD and SEM. Also, leakage current and sensitivity was measured to study radiation response characteristics. In addition, there was made a comparative study of radiation response characteristics on multilayer Cd(Zn)Te samples formed with dielectric layer and blocking layer. As results, the structure of deposited film was consisted of polycrystalline with Zincblend phase on CdTe and with Cubic zincblend on CdZnTe. The dark current of CdTe samples showed lower value at positive bias than negative bias, and then Cd_{0.85}Zn_{0.15}Te compared to CdTe was lower by a factor ~ 10 . Also, The lower and stable dark current was measured in sample consisted of ITO than Al as bottom electrode and the lowest dark current was obtained in Cd_{0.85}Zn_{0.15}Te sample of MOS structure formed with CeO₂ layer. In sensitivity measurement, in Cd_{0.85}Zn_{0.15}Te sample of MOS structure with ITO electrode the highest value was measured as total output charge and SNR were 180.44 pC/cm²(1.1×10^9 e-/cm²) and 6.19 at 30 V. In Cd_{1-x}Zn_xTe($x=0.15, 0.25, 0.3$) samples, dark current showed the lowest value of Cd_{0.7}Zn_{0.3}Te and output charge relatively showed similar values. These results was seemed due to thickness of Cd(Zn)Te layer. As results, the fabrication condition of Cd(Zn)Te based radiation detector was investigated using vacuum deposition method. In electrical measurement, as Zn composition increased the dark current was reduced due to increased resistivity, and then the Cd(Zn)Te detector of multilayer structure formed with dielectric and blocking layer protected from charge injection showed the feasibility as good radiation conversion layer for flat panel radiation imaging system. But, Increasing Zn composition, net charge reduced due to density reduction. Therefore the optimization of Zn composition in CdTe will be required.

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