Characterization of (Cd,Mn)Te and (Cd,Mn)(Te,Se) material and contact properties

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The basic parameters of materials used for semiconductor X-ray and gamma-ray detectors are carrier mobility (μ) and their lifetime (τ). Radiation generates hole-electron pairs in semiconductor detector material, an amount proportional to the energy of the incident radiation. Minimalization of carriers concentration results in increasing detector sensitivity. That leads to the creation of a semi-insulating material. The use of special material doping leads to material compensation and results in material resistances of the order of 10^{10}-10^{11} Ωcm. However, obtaining repeatable contacts for such highly resistive materials is very difficult. We have developed a method for obtaining nearly-ohmic contacts using amorphous layers based on CdTe, ZnTe, and (Cd,Mg)Te. The best I-V characteristics were obtained for materials with (Cd,Mg)Te:Sb contact layers and metallization. Properties of these contacts were investigated using scanning electron microscopy (SEM) and X-ray diffraction (XRD). We use current-voltage characteristics to examine the metal/amorphous layer/detector material interface.

For materials with resistivity of about 10^8-10^9 Ωcm we made Schottky contacts. This type of contact is achieved by selecting appropriate contact materials that act as barriers for injecting electrons from one side and holes from the other side of the detector material. Creating a depletion layer in the sample by applying voltage leads to an increase in the signal produced by charge carriers generated by radiation.

In this work, we present such contacts made on (Cd,Mn)Te and (Cd,Mn)(Te,Se) crystals doped with V, In, or V and In, respectively. We measured I-V characteristics, Time of Flight (TOF), and photocurrent as a function of the applied field (PC-V) for selected samples [1]. Data were collected as a function of temperature in the range of 0 to 70°C. The measurements allowed us to obtain mobility values for electrons ($\approx$ 880-980 $cm^2V^{-1}s^{-1}$) and holes ($\approx$ 30-50 $cm^2V^{-1}s^{-1}$). From measurements of parameter $\mu\tau$ ($\mu_e\tau_e \approx 1\cdot10^{-3}$ cm^2V^{-1}), we calculated an electron lifetime of the order of 10^{-6} s.

TOF measurements allow for the estimation of trapping and de-trapping processes. The I-V data enable us to determine barrier heights at the junction [2] and the activation energies of some states in the material's energy gap.

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