Extended Abstracts of the 1995 International Conference on Solid State Devices and Materials, Osaka, 1995, pp. 1061-1062

PD-L2-L6

The Application of CVD SiO_2 and PECVD Si_3N_4 in Fabrication and Passivation of Long-Wavelength HgCdTe Photodiode Arrays

V.M.Emeksuzyan, L.N.Romashko, G.Y.Saleeva, T.I.Zakharyash, N.Kh.Talipov, V.V.Vasil'ev and V.N.Ovsyuk

Institute of Semiconductor Physics, Siberian Branch of Russian Academy of Sciences, Novosibirsk 630090, Russia

Hybrid two-dimensional HgCdTe photodiode infrared focal plane arrays (FPA) are a future high-performance thermal imaging device. Very large FPA will give superior infrared sensors that provide a combination of sensitivity, high quantum efficiency, tunable absorption wavelength, high spatial resolution and field of view that are unmatched by other infrared sensor technologies. But it is generally difficult to fabricate infrared photodiode array with uniform properties because of both the properties of initial semiconductor material and the surface effects. So the reproducibility and uniformity of HgCdTe surface passivation are one of main requirements in photodiode array fabrication process.

In this work the process of fabrication of n^+-p HgCdTe photodiode arrays passivated with chemical vapor deposition (CVD) SiO_2 overcoated with plasma-enhanced chemical vapor deposition (PECVD) Si_3N_4 was developed. Photodetector arrays with 2×64 diodes are formed on p-type $Hg_{1-x}Cd_xTe$ with $x \approx 0.215$-0.235 and $p \approx 3.7\times10^{15}$ -2.9×10^{16} cm^{-3}. Shallow junctions n^+-p with area $S=50\times70$ μm^2 are formed by implanting boron ions at energy E=100 keV and dose of 3×10^{13} cm^{-2} at 300 K. The diodes are passivated with CVD SiO_2 at 100°C overcoated with PECVD Si_3N_4 deposited at 90°C on the surface of HgCdTe with native oxide, which was formed by exposure the wafers in the air after etching. Before and after deposition of dielectric layers the structures were annealed in vacuum. The properties of the HgCdTe-insulator interface (the fixed charge, the surface state density) are defined by the measured high-frequency (1 MHz) capacitance-voltage characteristics of a test MIS devices that are fabricated on the same wafers near by the photodiodes (fig.1). All measurements are performed at 78 K.

The surface characteristics of the dielectric films make its suitable both for diode passivation and for use as lithographic mask. The dielectric leakage current is $\leq10^{-9}$ A/cm^2 at biases U~1 V. The trap density of the interface insulator-HgCdTe is $\leq1.5\times^{10}$ cm^{-2}, fast

surface state density is $\approx 1.3\times10^{11}cm^{-2}$, dielectric films has a low fixed charge density of less than $\leq6\times10^{10}$ cm^{-2} at interface with HgCdTe, which ensure the peripheries of photodiodes are in the flat-band condition. These passivation properties give the photodiodes of the "best" arrays ideal, stable (2 years) current-voltage characteristics and high zero-bias

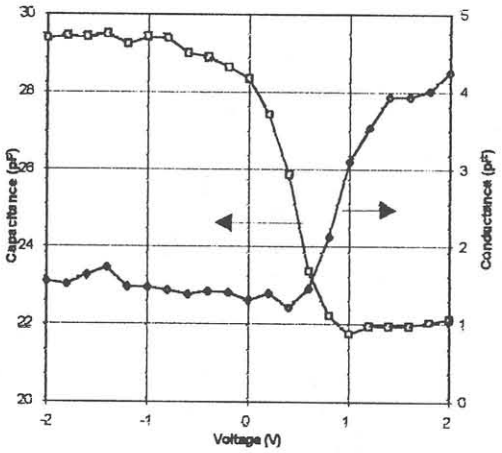

Fig.1. C-V and G/ω-V- curves of a test p-type MIS devices ($x\approx 0.227$, $p\approx 2\times10^{16}cm^{-3}$).

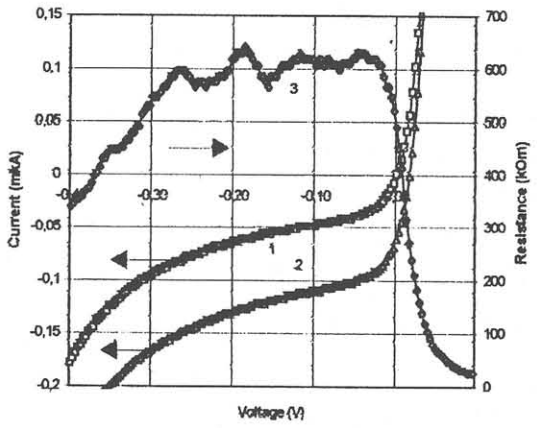

Fig.2. Typical current-voltage characteristics (1-dark, 2-background radiation at 293 K) and differential resistance (3) of a photodiode with $\lambda_{cut}\approx9.7$.

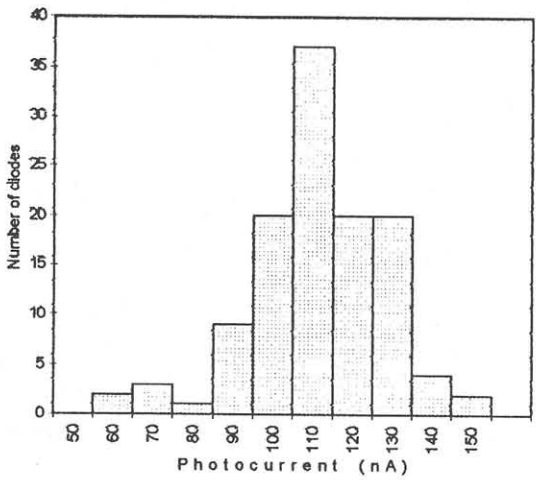

Fig.3. Histogram of photocurrent of n^+-p HgCdTe diode array.

resistance $R_o\sim0.5$ Mom. Typical current-voltage characteristics, dark and under the lighting by black body radiation (T_{BB}=293 K) and differential resistance of the diode with $x\approx0.228$ and $p\approx8\times10^{15}cm^{-3}$ are shown in fig.2. The histogram of photocurrent of array's diodes is shown in fig.3. The average photocurrent of 128 diodes is I_f=111.5 nA and the deviation of nonuniformity of $\sigma/m\approx15$ %.

Obtained results establish a fact of applicable of CVD SiO_2 overcoated with PECVD both for the use as lithographic mask in fabrication and for the passivation of HgCdTe photodiode arrays.