Lead telluride *p-n* junctions for infrared detection: electrical and optical characteristics

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This work reports on the electrical characterization of PbTe *p-n* junctions for application in photovoltaic detectors in the medium infrared range. For this purpose, a series of *p-n* junctions, where the hole concentration p was kept at 10^{17} cm^{-3} and the electron concentration n varied between 10^{17} and 10^{19} cm^{-3}, was successfully grown by molecular beam epitaxy on (111) BaF_2 substrates [1, 2]. Mesa diodes were fabricated by lithography and mounted in a liquid nitrogen cryostat for the electrical characterization and the determination of figures of merit (detectivity and spectral response). The results obtained by the CxV characteristic showed that for electron concentration $n > 10^{18}$ cm^{-3}, one-sided abrupt junctions were formed. In this case, the hole concentration and the depletion width could be determined. The IxV characteristic exhibited different forms for both reverse and direct branches, even for diodes fabricated from the same junction. The incremental differential resistance, the series and parallel resistances, and the ideality factor of the diodes were obtained by the derivative of the IxV curve and by a simulation program developed to adjust the curve calculated by the equation for a real diode to the experimental data. It was possible to correlate the noise and detectivity values measured for the PbTe detectors to the parameters obtained from the IxV characterization. These results allow the prediction of the detector's figures of merit from the data obtained from the IxV curves. It is also important to emphasize that the best PbTe photodiodes fabricated during this work showed D^* values close to 10^{11} cmHz$^{1/2}$W^{-1}, comparable to InSb and HgCdTe commercial detectors [3] and to PbTe photodiodes fabricated on silicon substrates [4].

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