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Student Paper

Development and Fabrication of Extended Short Wavelength Infrared HgCdTe grown on CdTe/Si Substrates by Molecular beam epitaxy

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The development and fabrication is reported for extended short-wavelength infrared (SWIR) HgCdTe (MCT) grown on CdTe/Si substrates. The MCT was deposited on CdTe/Si substrates using molecular beam epitaxy (MBE) [1][2]. Epilayers were evaluated using Fourier transform infrared spectroscopy (FTIR), x-ray double crystal rocking curve (DCRC), Van der Pauw Hall measurements, secondary ion mass spectroscopy (SIMS), dislocation defect-decoration etching and Nomarski microscopy[3]. FTIR analysis showed samples were grown around x = 0.45 providing a cutoff wavelength of 2.5 µm at 300 K. As grown epilayers had measured void defect densities less than 10^3 cm^{-2} and etch pit density around $1x10^7$ cm^{-2}. Hall mobility of annealed MCT samples are roughly on the order of $2x10^3$ cm^2/Vs and have carrier concentration around $1x10^{16}$ cm^{-3} at 300°K. Devices were fabricated through in situ In doping and ion-implanted As to create p/n diodes with sizes varying from 15 µm to 250 µm diameter diodes[4].

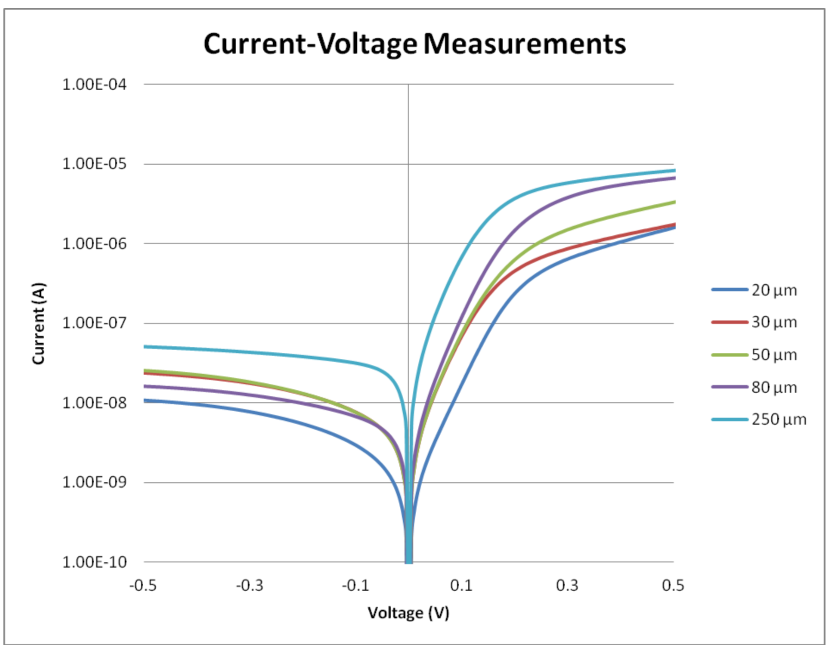

Figure 1. I-V measurements of various diameter diode at 300°K

The I-V measurements, as seen in figure 1, show good diffusion limited current in the forward bias, as expected. The reverse bias displays increasing shunt resistance with decreased diode size, which has been determined through fitting with various dark current components. At 80 µm, we observe a shift from diffusion-limited current to shunt-limited current. The shunt-limited current is likely due to passivation issues, especially in smaller area diodes. In figure 2, we show the dark current at -20mV. The exponential fit is used to determine the quality of the diode by comparing the bandgap from the material cutoff to the bandgap of the exponential fit.

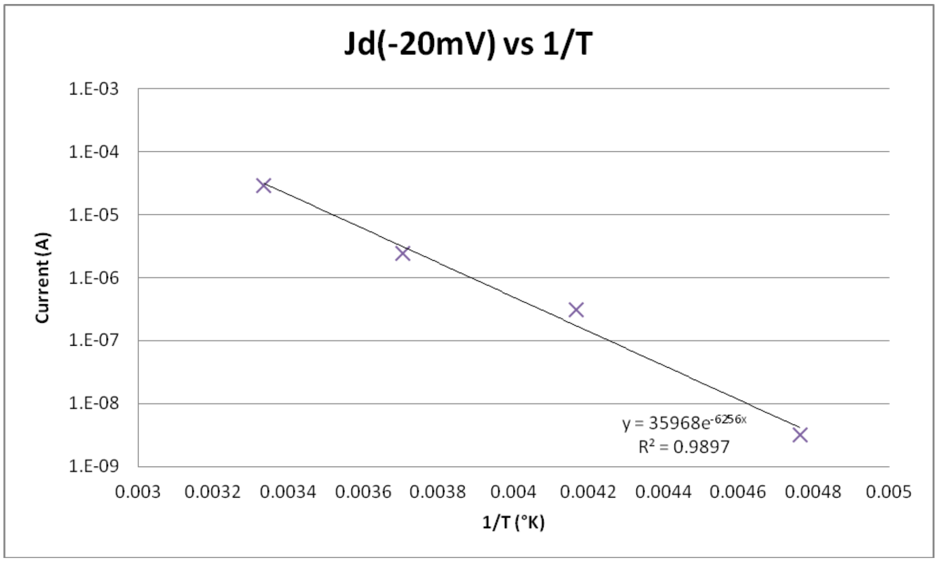

Figure 2. Dark current measurement vs 1/T for 250 µm diodes

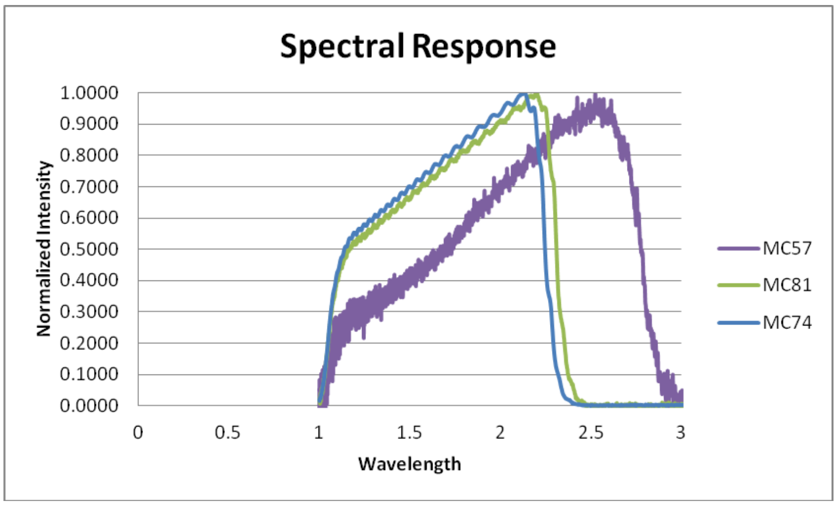

Figure 3. Spectral response for various samples

The spectral response, as seen in figure 3, shows good response over the SWIR region. In a few of our samples the composition was slightly off from x = 0.45, but responsivity was still acceptable. We will present the results and analysis of current-voltage (I-V) vs. temperature and room-temperature quantum efficiency measurements as compared to InGaAs with similar cutoff wavelength. The authors would like to thank DARPA for funding through contract #W911NF-11-2-0049.

References

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