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# Depth Profiling of Electronic Transport Parameters in *n*-on-*p* Boron-Ion-Implanted Vacancy-Doped HgCdTe

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We report results of a detailed study of electronic transport in *n*-on-*p* junctions formed by 150-keV boron-ion implantation in vacancy-doped *p*-type $Hg_{0.769}Cd_{0.231}Te$ without postimplantation thermal annealing. A mobility spectrum analysis methodology in conjunction with a wet chemical etching-based surface removal approach has been employed to depth profile the transport characteristics of the samples. In the as-implanted samples, three distinct electron species were detected which are shown to be associated with (a) low-mobility electrons in the top 220-nm surface-damaged layer ($E_1$: $\mu_{80K}$ = 2940 cm$^2$/Vs), (b) the B-ion implantation region in the top 500-nm region ($E_2$: $\mu_{80K}$ = 7490 cm$^2$/Vs), and (c) high-mobility electrons in the *n*-to-*p* transition region at a depth of 600 nm to 700 nm ($E_3$: $\mu_{80K}$ = 25,640 cm$^2$/Vs). Due to the maximum magnetic field employed (2 T), hole carriers from the underlying vacancy-doped *p*-type region were detected only after the removal of the top 220 nm of the profiled sample ($\mu_{80K}$ = 126 cm$^2$/Vs), revealing fully *p*-type character 800 nm below the original sample surface. A comparison of the extracted $E_2$ electron concentration and calculated B-impurity profile suggests that the *n*-type region is due primarily to near-surface implantation-induced lattice damage.

**Key words:** HgCdTe, mobility spectrum analysis, electronic transport, multiple carrier transport, ion implantation

## INTRODUCTION

Infrared photodetectors and infrared imaging arrays are becoming increasingly important in applications beyond their traditional niche in homeland security and search and rescue, including applications in medical diagnostics and scientific instrumentation, agriculture and food security, environmental monitoring, and mineral exploration. For imaging applications requiring high performance over the 3 $\mu$m to 5 $\mu$m and 8 $\mu$m to 12 $\mu$m spectral ranges, photodetectors based on HgCdTe have become the dominant technology over the past few decades.[1]

Among more complex device structures, relatively high-performance infrared photodetectors can be realized on *p*-type HgCdTe by forming an *n*-type layer via ion implantation,[2–8] ion milling,[9,10] reactive ion etching,[11–13] or even mechanically induced lattice damage.[14] For the case of ion implantation, the formation of this *n*-type region has been generally accepted to occur via a type conversion process whereby the release and diffusion of Hg atoms leads to a high density of donor-like defects (Hg interstitials) that compensate preexisting acceptors in the underlying *n*-type region.[2–8] This work presents results of a detailed study of electronic transport in boron-implanted *n*-on-*p* junctions in vacancy-doped

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