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Variable-Field Hall Measurement and Transport in LW Single-Layer *n*-Type MBE $Hg_{1-x}Cd_xTe$

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Molecular beam epitaxy *n*-type long-wavelength infrared (LWIR) $Hg_{1-x}Cd_xTe$ (MCT) has been investigated using variable-field Hall measurement in the temperature range from 50 K to 293 K. A quantitative mobility spectrum analysis technique has been used to determine the role of multicarrier transport properties with respect to epilayer growth on lattice-matched cadmium zinc telluride, as well as lattice-mismatched silicon (Si) and gallium arsenide (GaAs) buffered substrates. Overall, after postgrowth annealing, all layers were found to possess three distinct electron species, which were postulated to originate from the bulk, transitional (or higher-*x*-value) regions, and an interfacial/surface layer carrier. Further, the mobility and concentration with respect to temperature were analyzed for all carriers, showing the expected mobility temperature dependence and intrinsic behavior of the bulk electron. Electrons from transitional regions were seen to match expected values based on the carrier concentration of the resolved peak. At high temperature, the lowest-mobility carrier was consistent with the properties of a surface carrier, while below 125 K it was postulated that interfacial-region electrons may influence peak values. After corrections for *x*-value and doping density at 77 K, bulk electron mobility in excess of 10^5 cm^2 V^{-1} s^{-1} was observed in all epilayers, in line with expected values for lightly doped *n*-type LWIR material. Results indicate that fundamental conduction properties of electrons in MCT layers are unchanged by choice of substrate.

Key words: HgCdTe, electrical characterization, molecular beam epitaxy, quantitative mobility spectrum analysis (QMSA), Hall-effect measurement, multicarrier conduction

INTRODUCTION

Mixed-conduction effects relevant to advanced multilayer $Hg_{1-x}Cd_xTe$ (MCT) structures demand robust analysis that cannot be provided with standard electrical characterization techniques alone. The complexity of such structures requires simultaneous optimization of numerous material parameters, making characterization difficult. Therefore, it becomes critical to accurately quantify distinct carriers without resorting to destructive or compromising techniques. In the presence of multiple species, results obtained from traditional methods, namely single-field Hall measurement, prove insufficient and can lead to misinterpretation of results.[1] However, it has been shown that, by determining the magnetic field dependence of sample resistivity and Hall coefficient, it is possible to extract information about individual carriers as desired.

Long-wavelength infrared (LWIR) MCT commonly contains additional species aside from the

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