Characterizing Multi-Carrier Devices with Quantitative Mobility Spectrum Analysis and Variable Field Hall Measurements

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Conventional Hall mobility measurements conducted at a single applied magnetic field are unable to accurately characterize the electronic transport properties of multi-carrier heterostructure devices such as *p*HEMT, because the measured parameters are averaged over all carriers. In this paper, we will demonstrate a novel characterization technique, Quantitative Mobility Spectrum Analysis[1,2] (QMSA™) in conjunction with variable magnetic field Hall measurements that provides for the extraction of individual carrier mobilities and densities for multi-carrier devices. Temperature (2 – 400 K) and magnetic field (0 - 9 T) dependent Hall measurements and QMSA results for an InP *p*HEMT device will be presented. These results clearly show that high mobility 2DEG carriers in multiple subbands of the quantum well channel layer are distinguished by QMSA. The measurements also allow the temperature-dependent properties of the individual carriers to be determined. Shubnikov-de Haas quantum Hall measurements for this sample correlate with the QMSA results and confirm the presence of carriers in multiple subbands. The reliability and sensitivity of QMSA and variable field measurements show that this technique is a powerful measurement methodology for routine electrical characterization of multi-carrier semiconductor devices for both research and industrial QC/QA applications.

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