The role of defects in limiting the 2DEG mobility in AlGaN/GaN heterostructures

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ABSTRACT

We have studied the mobility dependence on temperature and electron concentration in $Al_xGa_{1-x}N$/GaN heterostructures. The lattice scattering was calculated and used as a background scattering. Due to imperfect growth there will be additional electron scattering from ionized impurities, dislocations and interface roughness. By considering the different electron scattering mechanisms the mobility was modeled and compared to available experimental data. At temperatures below 50 K the ionized impurity scattering and the line dislocation scattering was found to be limiting the mobility. For temperatures above room temperature the optical phonon scattering was dominant. In samples with a rough interface the mobility is significantly reduced by roughness scattering both at high and low temperatures. The electron transmission under the influence of the interface roughness is studied by solving the time-dependent Schrödinger equation, which shows a significant reduction in the electrical conduction. Heterostructure field effect transistors operating at high power levels require mobility above ~ 1000 cm^2/Vs. This is obtained when the ionized impurity concentration is less than 1×10^{17} cm^{-3}, the line dislocation density below 1×10^{10} cm^{-2}, the root-mean square value of the surface roughness is less than 1 nm and the lateral surface roughness correlation length larger than 5 nm.

Materials Processing for Properties and Performance (MP^3) Vol. 3
Edited by K.A. Khor, R. V. Ramanujan, C. P. Ooi and J. H. Zhao
Institute of Materials East Asia, 2004