Doping-Dependent Nonlinear Electron Mobility in GaAs|$In_xGa_{1-x}As$ Coupled Quantum-Well Pseudo-Morphic MODFET Structure

© S.R. Panda, A. Sahu, S. Das, A.K. Panda, T. Sahu¶

Department of Electronics and Communication Engineering, National Institute of Science and Technology, Palur Hills, Berhampur-761 008, Odisha, India

¶ E-mail: tsahu_bu@rediffmail.com

Received March 28, 2018
Revised March 4, 2020
Accepted March 4, 2020

We analyze the asymmetric delta-doping dependence of nonlinear electron mobility μ of GaAs|$In_xGa_{1-x}As$ double quantum-well pseudo-morphic modulation doped field-effect transistor structure. We solve the Schrödinger and Poisson's equations self-consistently to obtain the sub-band energy levels and wave functions. We consider scatterings due to the ionized impurities (IMP), alloy disorder (AL), and interface roughness (IR) to calculate μ for a system having double sub-band occupancy, in which the inter-sub-band effects play an important role. Considering the doping concentrations in the barriers towards the substrate and surface sides as N_{d1} and N_{d2}, respectively, we show that variation of N_{d1} leads to a dip in μ near $N_{d1} = N_{d2}$, at which the resonance of the sub-band states occurs. A similar dip in μ as a function of N_{d1} is also obtained at $N_{d1} = N_{d2}$ by keeping $(N_{d1} + N_{d2})$ unchanged. By increasing the central barrier width and well width, the dip in μ becomes sharp. We note that even though the overall μ is governed by the IMP- and AL-scatterings, the dip in μ is mostly affected through substantial variation of the sub-band mobilities due to IR-scattering near the resonance. Our results of nonlinear electron mobility near the resonance of sub-band states can be utilized for the performance analysis of GaAs|InGaAs pseudo-morphic quantum-well field-effect transistors.

Keywords: asymmetric double quantum wells, GaAs|$In_xGa_{1-x}As$ structures, nonlinear electron mobility, pseudo-morphic HEMT structures, resonance of sub-band states.

Full text of the paper will appear in journal SEMICONDUCTORS.