Growth and scattering mechanisms of metamorphic $In_{0.81}Ga_{0.19}As$ quantum wells

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$In_xGa_{1-x}As/In_xAl_{1-x}As$ quantum wells with a high In content are a material system with potential advantages over the GaAs/AlGaAs systems for spintronics and topological quantum computing applications. In comparison to the GaAs/AlGaAs quantum wells, $In_xGa_{1-x}As/In_xAl_{1-x}As$ quantum wells possess a lower effective mass, higher g-factor, and higher Rashba spin-orbit coupling. Due to a lack of latticed matched substrates, $In_xGa_{1-x}As/In_xAl_{1-x}As$ quantum wells are grown on latticed mismatched substrates such as GaAs and InP. However, the growth of high mobility $In_xGa_{1-x}As/In_xAl_{1-x}As$ quantum wells is hampered by enhanced interface roughness scattering from the metamorphic buffer layers and alloy scattering within the well [1].

In this work, we report the growth of modulation doped $In_{0.81}Ga_{0.19}As/In_{0.81}Al_{0.19}As$ quantum wells grown by molecular beam epitaxy on semi-insulating InP (001) substrates. The quantum wells are characterized with low temperature magnetotransport, which is performed using gated Hall bars and the van der Pauw geometry structures. Quantum wells with electron mobilities in excess of 380,000 cm^2/Vs have been grown. The role of growth parameters on electron mobility is discussed. The low temperature electron mobility and carrier density of the quantum wells is modeled to extract the dominant scattering mechanisms that limits the mobility. The influence of an InGaAs digital alloy on the electron mobility and alloy scattering of the quantum well is investigated.

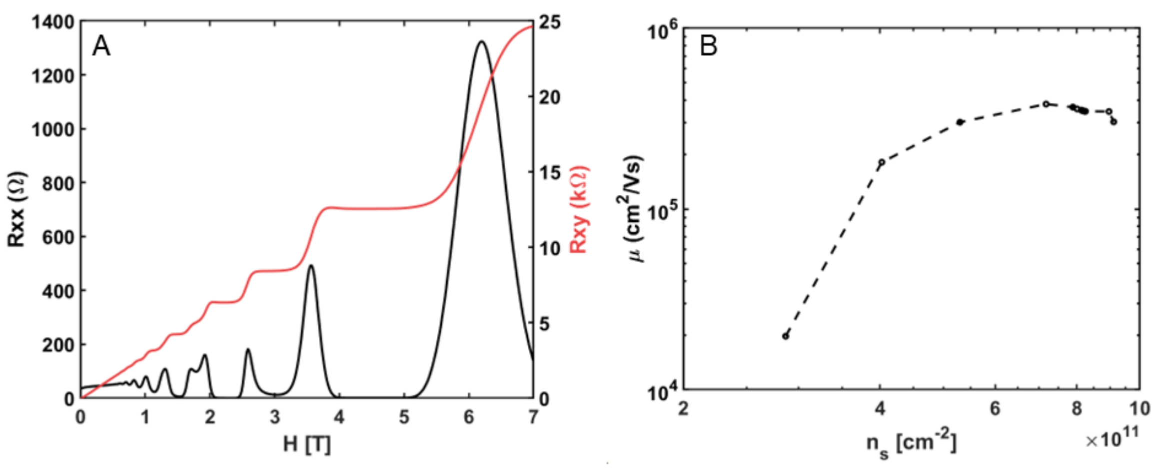

Figure 1: a) Low temperature magnetotransport of an $In_{0.81}Ga_{0.19}As$ quantum well. b) Electron mobility as a function of carrier density of a gated $In_{0.81}Ga_{0.19}As$ quantum well.

[1] Chen, C., Farrer, I., Holmes, S.N. et al., Journal of Crystal Growth **425**, 70–75 (2015).