Spin-orbit coupling in InGaAs random and digital alloy quantum wells

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InGaAs two dimensional electron gases (2DEGs) have high spin-orbit coupling, making them potentially useful for spintronics [1] and topological quantum computing applications [2,3]. With increasing In concentration, InGaAs quantum wells will have lower effective masses, higher spin-orbit coupling, and higher g-factors than GaAs quantum wells [4]. Digital alloying, or growing the ternary as a superlattice,is an alternative to growing ternary III-V as a random alloy. However, the effect of digital alloying on the spin-orbit coupling in semiconductor quantum wells is not understood. Digital alloy quantum wells can potentially enhance the Rashba spin-orbit coupling by forming asymmetric interfaces with the barrier layers. Here, we use molecular beam epitaxy and magnetotransport to the role of random and digital alloying of the spin-orbit coupling of InGaAs quantum wells.

We report the growth of high electron mobility $In_{0.81}Ga_{0.19}As$ quantum wells grown as a random and a digital alloy. From low temperature magnetotransport (2 K), the electron mobility of the random alloy quantum well is in excess of 450,000 cm^2/Vs and the electron mobility of the digital alloy quantum well is in excess of 540,000 cm^2/Vs. The spin-orbit coupling of the quantum wells is extracted from fits to the weak localization in the magnetotransport data and will be presented. We will also discuss the role of interfaces on the differences in the spin-orbit coupling observed in the random and digital alloy quantum wells.

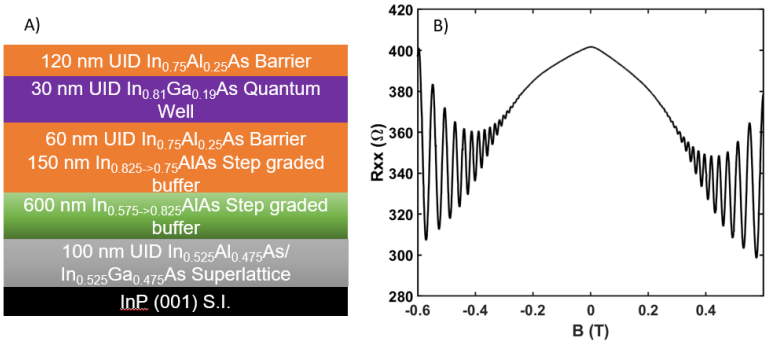

Figure 1: (A) Layer schematic of the InGaAs quantum wells. (B) Weak localization data of the InGaAs random alloy quantum well.

References

[1] *Appl. Phys. Lett.* **56**, 665 (1990)

[2] *Phys. Rev. Lett.* **105**, 077001 (2010)

[3] *Phys. Rev. Lett.* **105**, 177002 (2010)

[4] *Electron. Lett.* **37**(7), 464 (2001)

Supplementary Pages

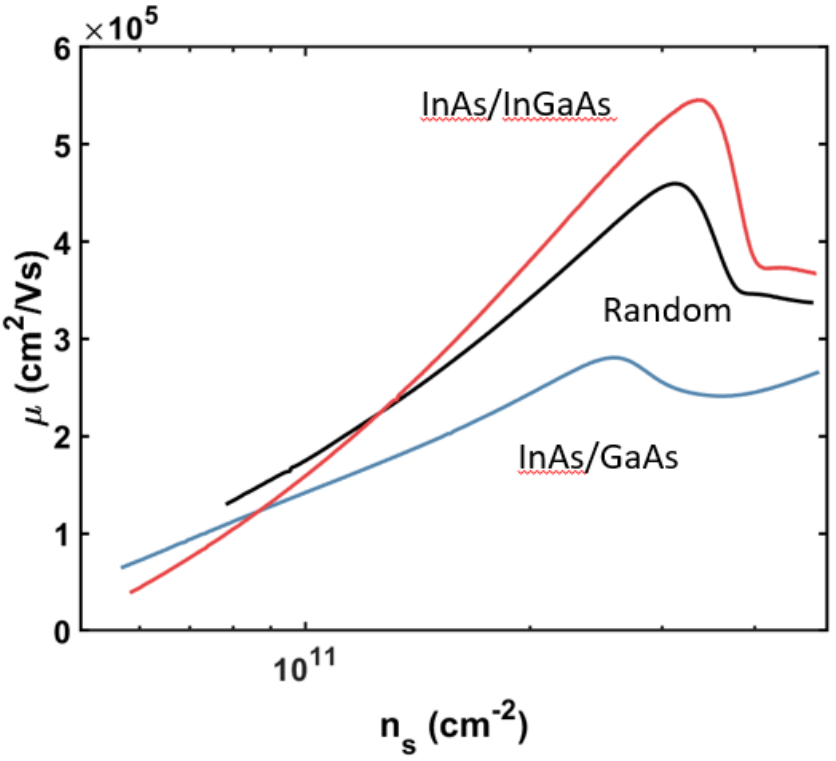

Figure S1: Mobility for different carrier densities for the random alloy and digital alloy quantum wells.

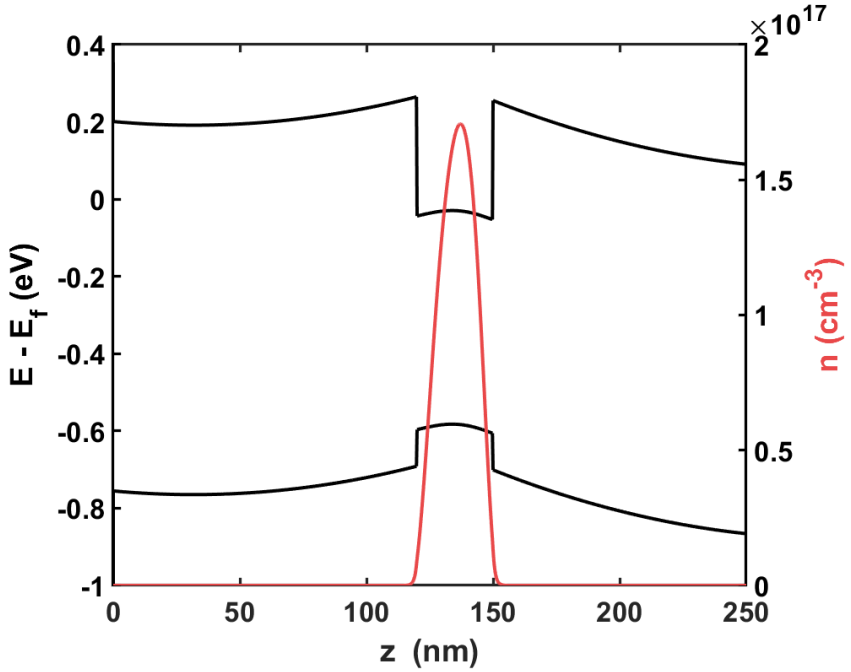

Figure S2: Self consistent Schrödinger-Poisson calculations of the band structure of the InGaAs quantum wells.