GaAs barrier insertion into MnAs/InAs hybrid heterostructures on GaAs(111)B for lateral spin valve device application

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In semiconductor spintronics, ferromagnetic-semiconductor hybrid structures have already emerged as potential candidate for spintronic applications, such as spin-field effect transistors (spin-FETs) [1]. Therefore, to realize spin-FET, we need to understand spin polarized carrier injection and detection in the hybrid structures. We studied lateral non-local spin valve device of molecular beam epitaxial (MBE) grown ferromagnetic-semiconductor hybrid structure, MnAs/InAs on GaAs(111)B and found spin-valve signal with spin polarization efficiency of ~8.5 % [2]. To enhance the spin polarization efficiency, insertion of tunneling barrier is expected to obtain good impedance matching for electrical spin injection [3]. Therefore, in this report, we grow three heterostructures with different GaAs barrier insertion (1, 3, 10 nm) into MnAs(50 nm)/InAs(200 nm) on semi-insulating GaAs(111)B substrate. The substrate temperatures were at ~480 °C for InAs and GaAs growth and ~250 °C for MnAs growth. The growth rate of GaAs was ~0.06 nm/sec. We measured reflection high energy electron diffraction (RHEED) as shown Fig.1. In the case of 1 and 3 nm GaAs barrier, there is no changing of lateral lattice distance. We only see that 10 nm GaAs barrier insertion shows changing of lateral lattice distance. The extracted lattice parameter of GaAs is close to bulk value (5.65 Å), thus it seems GaAs strain relaxation takes place in the case of 10 nm GaAs barrier insertion. In addition, we see that lateral lattice transition from InAs to GaAs starts around ~(3.6±0.2) nm. We also see almost no difference of MnAs(50 nm) lateral lattice distance grown on different GaAs barrier layers.

References

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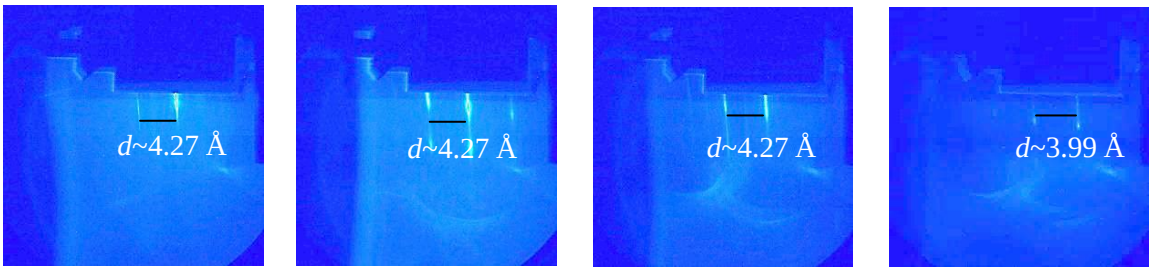
[3] E.I Rashba, Phys. Rev. B 62 (2000) R16267.



w/o GaAs InAs(200 nm) | GaAs (1 nm) | GaAs (3 nm) | GaAs (10 nm)

Figure 1. In situ RHEED pattern of <-110> for different barrier thickness GaAs on InAs.