MATERIALS STUDY FOR SPIN FIELD EFFECT TRANSISTORS USING MOLECULAR BEAM EPITAXY

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Abstract

Spin field effect transistor (spin-FET) is a typical model spintronic device. The spin-FET consists of well conductive non-magnetic semiconductor 1-dimensional channel, control gate for spin-polarized charge modulation, and ferromagnetic electrodes for spin polarized carrier injection/detection. We have studied base materials for spin-FETs using a conventional solid-source molecular beam epitaxy (MBE). In this talk, we report MBE growth and device application of MnAs/InAs hybrid structures and GaAs/InAs core/shell nanowires.

For MnAs/InAs hybrid structures, semi-insulating GaAs(111)B substrates were used to obtain hexagonal MnAs with c-axis normal to the plane on lattice-mismatch-grown InAs. After the hybrid structure growth, we fabricated lateral spin valve devices using electron beam lithography (EBL), Ar^+ ion milling, and evaporation/lift-off processes. We measured the devices with magnetic field and found non-local and local spin valve behaviors.

For GaAs/InAs core/shell nanowires, semi-insulating GaAs(001) substrates covered by hydrogen-silsesquioxane thin film were used to obtain pin-holes as nanowire growth nucleation sites. After the nanowire growth, we fabricated nanowire FET devices using EBL and evaporation/lift-off processes. We measured the devices at room temperature and found mobility modulation by gate bias.

The results indicate that our materials are potentially applicable to spin-FETs.

Key words: spin field effect transistors (spin-FETs), molecular beam epitaxy (MBE), MnAs/InAs hybrid structures, GaAs/InAs core/shell nanowires