Hybrid Ferromagnet-Semiconductor Spintronics

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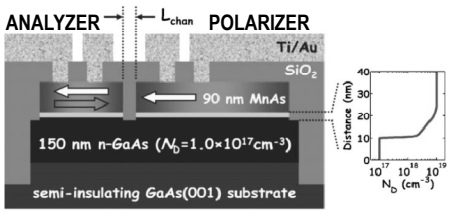
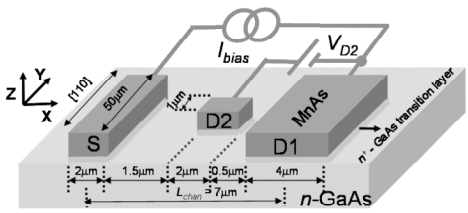
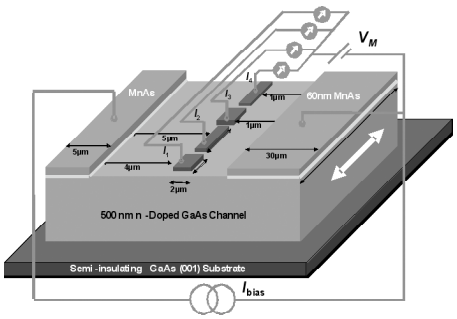
Semiconductor spintronics has been the subject of extensive experimental and theoretical studies aimed at developing spin-based devices which can outperform their charge-based counterparts. One essential building block from which a host of novel spintronic device concepts (e.g., spin-polarized field-effect transistors and reprogrammable magneto-logic) can be realized is a lateral semiconductor spin-valve. A fully-epitaxial lateral spin-valve utilizing ferromagnetic MnAs metal contacts has been demonstrated. Peak magnetoresistances of 3.6% at 10K and 1.1% at 125K have been measured in these devices. *A spin-current amplifier has also been demonstrated for the first time to overcome the barrier of low spin-injection efficiency of conventional ferromagnetic spin-injectors.* A spin-current polarization of 100% has been measured in these three terminal devices. The operation of MnAs/GaAs/MnAs lateral spin-valves has been extended to realize a memory device. A spin capacitor based on conventional lateral spin-valve is also realized by doping the GaAs channel with paramagnetic Mn impurities. This project is being supported by the Air Force Office of Scientific Research under award number FA 9550-07-1-0305 and by the Office of Naval Research under award number N 00014-06-1-0025.



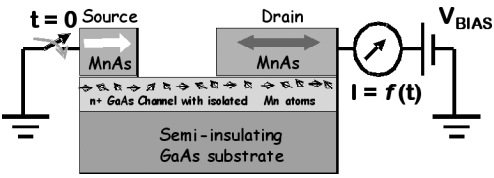
A schematic of MnAs/GaAs/MnAs lateral spin-valve.



A schematic of spin-current polarization amplifier.



A schematic of a multi-terminal memory device. The currents through the central contacts are measured to determine the state of the memory.



A schematic of a spin-capacitor. The spin information is stored in the electron spin of the Mn impurities.