Preparation of Thin Layers of Ferromagnetic Semiconductors

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Current electronic devices are based on charge of the electrons and holes. Widespread silicon based electronics is still developing to the higher performance but it is near its limit. One possible way for another improvement of electronics devices lies in using of a spin of electrons or holes.

For using of the spin polarized current it is necessary to add ferromagnetic properties into semiconductor materials. One proposed way is diluting metal atoms (manganese) in a semiconductor from group IV A (silicon or germanium). Diluted metal should have half-filled outermost electron shell, which brings the best magnetic moment of an atom.

Highly non-equilibrium conditions are applied for preparation of Si/Mn or Ge/Mn amorphous materials by a reactive excimer laser ablation. A manganese target is ablated under low pressure of silane (SiH_4) or germane (GeH_4) by a focused ArF laser beam. The ablated manganese atoms interact with SiH_4 or GeH_4 molecules in the gas phase. As a result, thin amorphous silicon or germanium layers with incorporated manganese atoms (with concentrations up to 50 %) are deposited. The deposited layers are analysed by electron microscopy (both scanning and transmission), X-ray photoelectron spectroscopy and SQUID (superconducting quantum interference device) techniques. Electron diffraction is used for identification of nano-crystallites formed by annealing of the deposit at temperatures up to 1100 °C.

References

1. E. S. Demidov, et al., High-temperature ferromagnetism in laser-deposited layers of silicon and germanium doped with manganese or iron impurities. J. Magn. Magn. Mat. 321 (2009) 690 – 694
2. L. Ottaviano, et al., Room-temperature ferromagnetism in Mn-implanted amorphous Ge. Phys. Rev. B 83, (2011) 134426