Study of the structure of Group IV based Diluted Magnetic Semiconductors

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Group IV Diluted Magnetic Semiconductors (DMS) are being studied because they may lead to electric-field controlled ferromagnetic order in a technology that is compatible with Si-based devices.

The incorporation of Mn atoms in a Ge host semiconductor is a current issue. Indeed, due to its low solubility in Ge, Mn tends to undergo phase separation and form Mn-rich clusters [1]. Previous studies have shown that Mn in substitutional sites in Ge are double acceptors, forming a p-type doped Ge whereas interstitial Mn are donors which compensate the holes and the magnetic contributions provided by the substitutional Mn atoms [2-4]. Computer simulations concerning the optimization of Mn doping in group IV semiconductors have shown numerically that codoping Ge with Mn and a n-type dopant simultaneously can increase the proportion of substitutional Mn through the formation of n-p pairing [5]. Previous results tend to prove that incorporating Mn in a Ge-rich SiGe host semiconductor energetically favors the the position of Mn in substitutional sites [6].

In this study, Molecular Beam Epitaxy was used to grow epitaxial layers on Ge (001) substrates. We attempted to characterize Mn-doped Ge and Mn-doped SiGe with different Ge concentrations. The characterization of ferromagnetic properties of the material after growth is done with a Superconducting QUantum Interference Device (SQUID). Our TEM results for Mn-doped Ge have confirmed the presence of Mn phase separation and tendency to form clusters.

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