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Mn dopant distribution and magnetic ordering in Mn-doped Ge ferromagnetic semiconductor AN-PING LI, K. VON BENTHEM, M.F. CHISHOLM, K. VARGA, J. SHEN, Oak Ridge National Laboratory, N. RAO, S.K. DIXIT, L.C. FELDMAN, Vanderbilt University, H.H. WEITERING, The University of Tennessee — We report the spatial distribution of Mn dopant atoms in germanium, grown with molecular-beam epitaxy. Cross-sectional transmission electron microscopy shows the stripe-shaped nanostructures with 2 nm in diameter, which arise from the chemical phase separation of the Mn dopants. Electron energy loss spectroscopy and ion-channeling spectroscopy indicate that these nano-stripes have $\sim$5 times higher Mn concentration than in the dilute doped Ge host. Only about 20% of total Mn atoms are incorporated in Ge lattice sites. Ferromagnetism in the doped Ge is characterized by two different ordering temperatures. A critical temperature T_C* is obtained as ferromagnetic spin clusters form, and a second transition occurs at much lower temperature Tc at the onset of global ferromagnetic ordering. Both transition temperatures can be enhanced significantly by an appropriate post-annealing process. The Mn aggregated clusters provide seeds of magnetic spin clusters, these spin clusters expand in size with lowering temperature and percolate eventually to form infinite magnetic clusters at low temperature.
[1] A. P. Li, et al., Appl. Phys. Lett. **86**, 152507 (2005).
[2] A. P. Li, et al., Phys. Rev. B 72, 195205 (2005).

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