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Effects of complementary doping of transition metals into Ge epitaxial films BRIAN COLLINS, LIANG HE, FRANK TSUI, University of North Carolina, YUNCHENG ZHONG, STEFAN VOGT, YONG CHU, Advanced Photon Source — We report structural and magnetic properties of epitaxial films of Co and Mn co-doped Ge, grown by combinatorial molecular beam epitaxy on Ge (001) substrates. A ternary epitaxial phase diagram has been determined for total doping concentrations up to 30 at. %, where regions of coherent epitaxy and associated strain states, and regions of rough disordered growth and the nature of the disorders have been examined and identified. In the phase diagram, there are two adjacent regions in composition, one Co-rich and another Mn-rich, where pseudomorphic epitaxial growth can be achieved at combined doping concentrations as high as 17 at. %. These values are significantly higher than those from using either of the dopants individually. The lattice constants of the Co-rich films obey the Vegard's law, i.e. a linear dependence on the concentration, while the Mn-rich counterparts do not. This finding indicates that two transition metal dopants can compensate for the internal stress caused by the individual dopants in the host lattice. Our results also show that the presence of a second dopant can significantly reduce the tendency for phase separation and disorder, especially when Mn is the primary dopant. A ternary magnetic phase diagram has been determined using the magnetooptic Kerr effect, within which there exit high quality epitaxial films of magnetic semiconductors.

Frank Tsui
UNC

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