Self-Assembled Silicide Quantum Dots on Epitaxial Si-Ge Layers on (001)Si

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The fabrication of self-assembled metal nanodots is of both fundamental interest and technological importance. Nanoparticles with appropriate physical and chemical properties are considered to be ideal building blocks for two- and three-dimensional cluster self-assembled superlattice structures. In this presentation, we report the results of an effort to grow self-assembled NiSi and $FeSi_2$ quantum dots on epitaxial Si-Ge films on (001)Si.

NiSi and $FeSi_2$ quantum dots were formed on $Si_{0.7}Ge_{0.3}$ on (001)Si with a sacrificial amorphous Si (a-Si) interlayer. 500-nm-thick $Si_{0.7}Ge_{0.3}$ and 1-micron-thick strained layers of Si_yGe_{1-y} (y varies from 1 to 0.7) were grown on (001)Si wafers at 550 ^{0}C by molecular beam epitaxy (MBE). Strains due to the lattice mismatch between $Si_{0.7}Ge_{0.3}$ and Si were released by forming dislocations in the buffer layer. A sacrificial a-Si layer was then deposited onto a $Si_{0.7}Ge_{0.3}$ substrate, followed by the deposition of metal thin films without breaking the vacuum at room temperature. A spatially varying strain field was generated by the growth of a SiGe alloy layer. NiSi and $FeSi_2$ quantum dots, 2-3 nm in size, were found to form in samples annealed at 500-600 ^{0}C. The regularly distributed quantum dot arrays are correlated to the extension of strain field of misfit dislocations to the surface. The effects of variation in Ni, Fe and a-Si layer thickness, alloy composition and annealing temperature are currently being investigated.