Electrical & Computer Engineering

S E M I N A R

Louisiana State University

Fabrication of Quantum Dots and Embedded Insulator Structures in Si Using Solid-Metal Mediated Molecular Beam Epitaxy (SMM-MBE)

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Abstract—A new method for economical, low thermal-budget, fabrication of embedded insulator structures and quantum dots in single crystalline Si layers will be presented. The method also provides epitaxial metallization and high p-type doping in a single processing step. The method is based on solid-metal mediated molecular beam epitaxy (SMM-MBE), a new phenomenon in which a semiconductor material grows at a buried semiconductor/ metal interface during thermal evaporation of the semiconductor.

The SMM-MBE method will be described in details together with some of its applications in nanoscale device fabrication. The method provides an economical solution to some of the challenges facing current ULSI technology. Specifically, the observation is made in the aluminum silicon system in which surface reconstruction induced epitaxy defines the relationship between the underlying Si (111) and the overlayer A1 (111) metal. In contrast with previous observations in both solid-phase epitaxy (SPE) and liquid-metal mediated epitaxy, the epitaxial growth is spontaneous, defect free, and planar. Initial experiments on growing epitaxial Si layers with buried aluminum oxide dots were successful with no measurable defects in the Si SMM-MBE layer. Pellets of aluminum oxide with lateral dimension as large as 14nm were buried in the SMM-MBE layer at the original Al/Si interface. These initial results demonstrate the possibility of growing predefined embedded insulator structures in the Si matrix.

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