Molecular Beam Epitaxy (MBE) growth of metal/Si layers on Si(100): arrays of 3D metal islands exhibiting self-organization features.

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The technological need for new and improved nano-scale lithography methods has stimulated investigations on the self-assembly approach, which is believed to give a cost-effective and technological simple way of obtaining uniform arrays of nano-structures. Overlayers formed either by Stransky-Krastanov or Volmer-Weber growth modes are being extensively studied for this purpose. Moreover, the use of spacing layers in semiconductor heteroepitaxy has been found to improve the order and size distribution of 3D nanometric islands [1]. Here we explore the viability of using MBE-grown films, formed by metal (Ag, Co, Fe,…) and Si layers, in order to build large-scale uniform arrays of metallic nanostructures on Si (100) wafers. A variety of growth conditions (substrate temperature, deposition rate, thickness…) is studied for each material layer, paying particular attention to the Si buffer layer used as template. Samples are characterized by RHEED, LEED, AES and AFM techniques. The AFM images reveal that, for certain growth conditions, arrays of 3D metal islands can be actually obtained, which exhibit self–organization features, specific alignment with respect to the substrate and a certain uniformity in shapes (truncated pyramids) and sizes (see figure below).

Keywords: Molecular beam epitaxy, cobalt, iron, silver, silicon, self-assembly, nanostructures

References:
[1] C. Teicher. Physics Report 365 (2002) 335-432.

Figure: AFM data corresponding to the surface of a [Ag/Si] multilayer grown by MBE on Si(100) 2x1 surfaces with a Si buffer layer.