Thin Films and Coatings

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Scanning Tunneling Microscopy of Cu, Ag and Au Nanoformations on the Monocrystalline Surfaces

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Using high-vacuum high-resolution scanning tunneling microscopy we have investigated the processes of hexagonal-pyramidal Cu, Ag and Au structures formation after thermal sputtering of metals onto monocrystalline Si (1 1 1) and Si (1 1 0) surfaces (Fig. 1-3). It was found that under homogeneity of melt of deposited metals and vacuum not lower than 10^{-8} Pa there are formed self-ordered hexagonal-pyramidal nanostrucutres consisting of monoatomic layer planes each shifted by a distance of about 3 nm relatively to the growth start of the previous plane (Fig. 1-3). The mechanism of formation of hexagonal-pyramidal Cu, Ag and Au nanostructures is determined with a character of electron density behaviour at the edge of each monoatomic layer. Extreme atoms of planes have higher energy state and thereby growth of each next monoatomic plane starts not from the edge but at the distance of about 3 nm from it what is caused with relaxation of inhomogeneity of electron density of states at this distance and determines pyramidal shape of formations. During thermal deposition of silver (Fig. 2), after the formation of 3-4 monolayers, observe the formation of grain boundaries, which with further deposition begin to combine. The result of "two-dimensional" grain boundaries combine are the topological features in the form of wells (depth of ~ 0.4 Å). Annealing by heating to 300 °C, recreates intact structure 7x7.

By other metals deposition modes there was observed formation of conglomerates of nanoparticles with subsequent transformation of them into ellipsoidal particles and further nanocrystal formation.

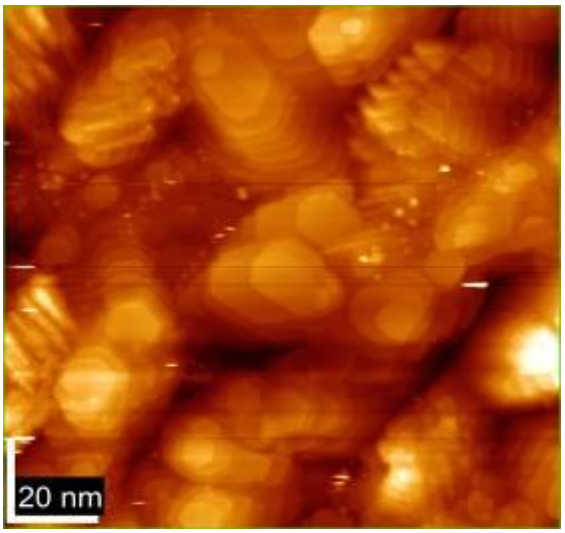

Figure 1. Au nanoformation on the Si (111) surface.

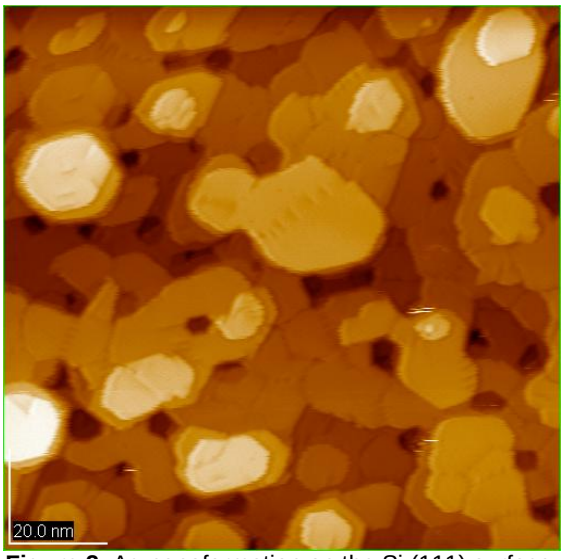

Figure 2. Ag nanoformation on the Si (111) surface.

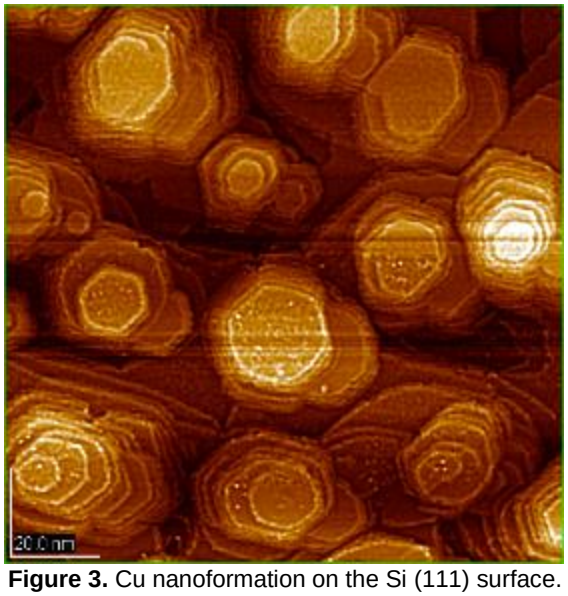

Figure 3. Cu nanoformation on the Si (111) surface.