Role of Transition from Atomically Smooth to Atomically Rough Growth Surface at Formation of Condensates Architecture

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When depositing substance under near-equilibrium conditions, it is spatially distributed selectivity of fixing of adatoms on a growth surface that determines structure formation of three-dimensional condensates. Extremely low supersaturation corresponds to a certain value of a critical energy of adatoms binding with the growth surface (E_c) that divides the whole binding energy spectrum in two parts. Substance condensates onto the area of the growth surface with desorption energies E_{di} higher than E_c, and, on the contrary, there is no condensation onto the areas with E_{di} lower than E_c. If changing the position of E_c in the binding energy spectrum by varying supersaturation of vapours, the transition from atomically smooth to atomically rough growth surface becomes possible. As a result, one can produce various corresponding architectures of three-dimensional layers. In the present work we study experimentally structure formation of single-component metallic condensates (Ni, Cu, Al, Ti) at varying extremely low supersaturation of deposited vapours. The main focus of the study is transition from tangential to normal growth of structural elements of condensates at reducing the supersaturation.

Substance was deposited in high-pure inert ambient by means of modified magnetron sputtering system with hollow cathode under low discharge power (~2-28 W), high growth surface temperatures (~350-670 ^{0}C) and increased working gas pressure (argon) ~3-25 Pa. Structure and surface morphology were investigated by electron microscopy techniques.

General regularities of growth under near-equilibrium conditions are of approximately the same character for all studied metals. When lowering the supersaturation, for example, by increasing the growth surface temperature or reducing the deposited flux in a certain range, faceted structural elements of porous condensates give place to rounded shapes. This is accompanied by change from tangential (layer-by-layer) growth of atomically smooth growth surface to normal growth of atomically rough surface. At the moment of this transition the condition $E_{(hkl)} < E_c < E_{ar}$ is met ($E_{(hkl)}$ is the maximal binding energy of an adatom on atomically smooth surface (*hkl*), E_{ar} is the binding energy of an adatom on atomically rough surface), and the monostep free energy turns into zero. It is found that the porosity character also changes as a result of the above transition, and sizes and concentration of pores usually decrease.