Regularities of Chromium Condensates Structure Formation under Volmer-Weber Conditions and Critically Low Supersaturations

Perekrestov V.I., Kornyushchenko A.S., Natalich V.V.

Sumy State University, Sumy, Ukraine

At present porous materials and three-dimensional structures with developed surface are widely used as sensor, catalysts, sorbents, fuel cells and other active elements. One of the method of low-dimensional porous system formation is based on self-assembling processes at condensation under near thermodynamic equilibrium conditions. The information concerning mechanisms of metal condensates structure formation under Volmer-Weber near equilibrium conditions is limited. At the same time, in our preliminary experiment in this area Cu, Al, C, Ti condensates were obtained in the form of porous three-dimensional system consisting of micro- and nanosized structural elements [1].

In this work the formation regularities of chromium layer under Volmer-Weber conditions at critically low supersaturations have been investigated. The low-dimensional chromium structures with different morphologies (network structures, agglomerations of weakly bounded crystals, columnar structures) have been obtained using unbalanced magnetron stutterer operating under extremely weak vapor fluxes and high growth surface temperatures.

Generalizing the results obtained, it has been established that the near equilibrium Volmer-Weber nucleation processes differ significantly from well-known concepts of substance condensation at the high supersaturations. Under conditions of critically low supersaturations the primary nucleation of subcritical chromium nuclei occurs mainly on active centers of the (001) KCl surface. The following secondary nucleation, as a rule, takes place on the primary clusters-substrate interface or on the structural defects of primary clusters aggregations. The active centers localization near primary clusters aggregation areas leads to formation of network structures and fractal fragments, which serve as a basis for the subsequent low-dimensional porous systems formation. It should be noted that the working gas pressure and the negative bias application to the substrate are very important technological parameters, which influence the structure formation mechanisms significantly.

5. Perekrestov V.I., Kosminska Yu.O., Mokrenko A.A., Kononenko I.N., Kornyushchenko A.S., Structure formation mechanisms of low-dimensional systems under quasi-equilibrium steady-state conditions // Vacuum. – 2011. – V.86, №1. – P. 111-118.