Nanostructured surfaces

Scaling properties of pyramidal islands formation process at epitaxial growth

V.O. Kharchenko[1], D.O. Kharchenko[1], A.V. Dvornichenko[2]

[1] *Institute of Applied Physics, Natl. Acad. of Sci. of Ukraine. Petropavlovskaya St., 58, Sumy-40000, Ukraine.*
E-mail: vasiliy@ipfcentr.sumy.ua

[2] *Sumy State University. Rimskii-Korsakov St., 2, Sumy-40007, Ukraine.*

We have studied scaling properties of both the surface morphology and process of pyramidal structures formation in the framework of generalized phase-filed model for epitaxial growth, taking into account relaxation processes of the temperature of adsorbate.

It is shown, that the process of pyramidal structures formation and the number of layers in pyramidal structures can be controlled by the temperature field relaxation time, deposition flux and interaction strength of the adsorbate. Using the dynamics scaling hypothesis we numerically analyze auto-correlation function of the surface height and show, that the roughness of the surface at late stages of the pyramidal growth process depends on the relaxation time of the temperature of adsorbate toward substrate temperature. Making an analysis of the growth exponents we have found, that an increase in the temperature relaxation time accelerates surface growth at early stages. It is shown that the growth rate of the averaged mean area of islands can be controlled by the deposition flux, the interaction strength and the temperature field relaxation time.

Studying scaling properties of the pyramidal islands growth we have shown that the average number of islands growths in time in a power-law form and the mean area of the islands on the mean height level of the growing surface decreases in time in the same power-law form. Moreover, the corresponding power law is invariant to a variation in the main control parameters governing scaling exponent. According to the power-law dependencies of the mean number of islands and the mean islands area we found that the probability density function of island size distribution obeys the Zipf law. The character of the probability and the probability density functions does not depend on the main system parameters.

The obtained results can be used to describe scaling properties of the pyramidal islands formation and roughness of the growing surface in wide range of systems (metals or semiconductors) where the temperature of the condensate can be locally changed during the epitaxial growth.