Nanostructured surfaces
Influence of adatoms dipole-dipole interaction on the dispersion law and acoustic phonon mode width of quasi-Rayleigh wave

M.Ya. Seneta, **R.M. Peleshchak, V.B. Brytan**

Drohobych Ivan Franko State Pedagogical University, Drohobych-82100, Ukraine. E-mail: marsen18@i.ua

As it is known, characteristics of surface waves dissemination – areas of existence, spectrum, acoustic phonon mode width, field distribution, – depend on surface properties and bound of environments division. In particular, they are modified substantially if the surface has the adsorbed atoms or surface (division bound) is not smooth and has periodic or random roughness. The surface waves multiple scattering is occur on adsorbed atoms and on surface roughness.

Let in the molecular beam epitaxy process (MPE) the atoms flux is directed on the semiconductor surface *z=0* (the axis z is directed into the single crystal depth) [1]. At considerable concentrations the adsorbed atoms are interacting with each other, with the substrate atoms and with the surface acoustic wave through the deformation potential.

The purpose of this work is to research the influence of adatoms dipole-dipole interaction V_{dd} on the spectrum and acoustic phonon mode width of quasi-Rayleigh wave.

Equations for the dispersion law of the surface acoustic wave and its width are found from the condition of lateral mechanical stresses balance and from the equality of normal mechanical stress on the semiconductor surface with adsorbed atoms:

$$(q^2+k_t^2)^2-4q^2k_lk_t=-\frac{2}{\beta}\frac{\omega^2}{c_l^2}\frac{\theta_d N_{0d}}{k_BT\rho c_l^2}\cdot\frac{D_dq^2}{-i\omega+D_d\left(1-\frac{2(1-2\nu)}{3K(1-\nu)a}\frac{\theta_d{}^2N_{0d}}{k_BT}-\frac{3}{2k_BT}V_{0dd}\right)q^2}\cdot$$

$$\times(1-l_d^2q^2)\cdot\left(q^2k_t\frac{\partial F}{\partial N_d}+(q^2+k_t^2)\frac{\theta_d+V_{0dd}}{2a}\right).$$

As a result of researches we have got in the long-wave approximation the expressions for dispersion law and phonon surface acoustic mode width taking into account the dipole-dipole adatoms interaction. It is shown that the result of dipole-dipole adatoms interaction is an increase of phonon mode width.

1. R.M. Peleshchak, M.Ya. Seneta, Condens. Mat. Phys. **19**, 43801 (2016).