SAXS domain structure characterization of a GaAs-GaSe multilayer film using irradiation wavelengths near absorption edges

Michael E. Boiko, Michael D. Sharkov, Andrei M. Boiko and Alexander V. Bobyl

[1] *Ioffe Physico-Technical Institute, St. Petersburg, Russia*

An effective approach to studying substance domain structure is provided by the technique of small-angle x-ray scattering (SAXS). This experimental method allows one to estimate sizes and shape of homogeneous fragments of the sample (domains, grains, clusters, pores, etc.) as well as determine spatial features of superstructures (e.g. superlattice interplanar distances and layer widths). A special role in multiphase specimen characterization is played by SAXS data sets measured at wavelength values close to absorption edges concerned to the atoms constituting the sample substance. Comparing such SAXS spectra one can get a way to relate separate results of SAXS analysis to sample components with a certain chemical composition.

A multi-layered GaAs-GaSe film was subject to SAXS measurements at three wavelength values: 1.54 Å (the Cu K_α line magnitude), 1.043 Å (slightly shorter than the As K edge), 0.979 Å (unsubstantially shorter than the Se K edge). The SAXS spectrum obtained with the help of the Cu $K_{\boldsymbol{\alpha}}$ wavelength beam is represented at Fig. 1.

The SAXS spectrum measured at the Cu $K_{\boldsymbol{\alpha}}$ beam wavelength happened to contain a wide Bragg peak that could correspond to different values of superstructure spatial parameters (from 15 nm up to 30 nm). Nevertheless, the SAXS curve obtained with the help of the beam harder than the As K edge included a Bragg peak explicitly corresponding to the spatial parameter value of about 15 nm. Thus, this meaning might be related to the specimen components without As atoms (e.g. GaSe domains forming a regular net along the film surface).

In turn, the SAXS data set measured using the beam with energy higher than the Se K edge included a Bragg peak reflecting the spatial parameter magnitude about 25 nm. This one, therefore, must be related to the sample components consisting of atoms but Se, i.e. with GaAs chemical composition. Thus, the size value of 15 nm has been connected with the GaSe compound while the GaAs composition has been stated to correspond to the value of 25 nm.

It is argued that the alleged film of solid solution GaAs/Se splits into multilayers of GaAs and GaSe. Density waves at SEM photos corresponded to packs of such sublayers.

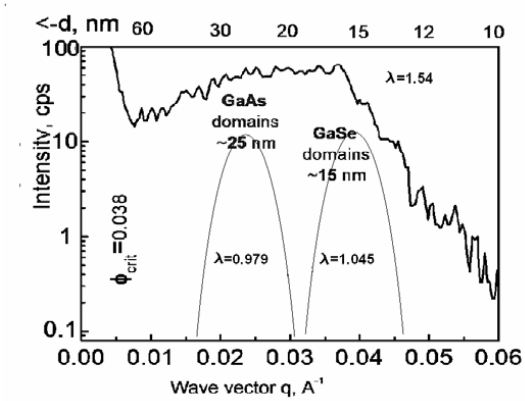

Fig. 1. SAXS data registered for the GaAs-GaSe multilayer film at the Cu K_α beam wavelength.