## Nanoobjects microscopy

# Direct determination of 3D distribution of elemental composition in single $Ge_xSi_{1-x}$/Si nanoislands by scanning Auger microscopy, HRSEM, Raman spectroscopy and AFM

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Application of self-induced growth mode according to Stranski-Krastanov model is one of the most promising ways of nanostructures formation, particularly, Ge epitaxy on Si substrate. Arrays of self-assembled Ge and SiGe nanoislands have been intensively investigated in the past decade due to their potential applications in near-IR optoelectronics and microwave devices and detectors. To fabricate high performance devices, it is necessary to know and control the electronic and optical properties of nanoislands. These physical properties critically depend on the following parameters: size, shape, surface density, homogeneity of distribution, mechanical stress and elemental composition of nanoislands.

The structures studied in this work were prepared by molecular beam epitaxy. The first specimen A 1 was produced by depositing Ge on Si (001) substrate with rate $v_{dep} = 0.07$ Å/sec at the temperature $T_{grow} = 700^oC$. The nominal thickness of the germanium layer was 8.7 ML. Right after completion of the nanoislands growth the structures began to cool down at the rate of $1^oC$/sec. The second specimen A 2 was grown under the same conditions. In this case Ge was deposited on the buffer layer $Si_{0.9}Ge_{0.1}$ with 10 nm thickness, while the nominal thickness of the germanium layer was 8 ML.

The high-resolution (3 nm) SEM (HRSEM) coupled with Local (5÷8 nm) Auger Electron Spectroscopy (LAES) and AFM were used for a comprehensive study of the elemental composition and geometrical parameters of nanoislands. The Field Emission Auger Microprobe JAMP-9500F (JEOL, Japan) equipped with Ar+-ion etching gun was used for a layer-by-layer analysis of the nanoislands in the growth direction. The high spatial resolution of LAES, capable of obtaining Si, Ge, C and O depth profiles of an individual nanoisland, was achieved by using the electronic correction of the probed spot drift. The results obtained from LAES for an individual island were compared with the data obtained by micro-Raman spectroscopy, averaged over both many nanoislands within the ensemble and over the height of the particular nanoisland.