4.3.10. METROLOGY AND STANDARDIZATION FOR NANOTECHNOLOGIES

Todua P.A., Center for Surface and Vacuum Research (Research Institute), Moscow Institute of Physics and Technology (State University), Moscow, Russia

Specific features of nanotechnology caused the development of nanometrology – the new metrology research field, which is connected with all theoretical and practical aspects of metrological ensuring the uniformity of measurements for nanotechnologies.

Nanometrology includes, first, standards of measuring and reference devices, as well as standard samples of composition, structure and properties to ensure the traceable transfer of the size of the physical quantity to the nanometer range. Second, it includes certified or standardized measurement methods for physical-chemical parameters and properties of nanotechnology objects, as well as methods of calibration (verification) of actual measuring instruments being used in nanotechnologies. Third, it includes metrological support for manufacturing of nanotechnology-based products.

It follows from the definition of "nanotechnology", operating with objects at the nanoscale, that the top priority task for nanotechnologies is the measurements of the object's geometrical parameters. This leads to the necessity of providing the uniformity of dimensional measurements in the nanometer range. However, for nanometrology the role of dimensional measurements is not exhausted by this circumstance. The dimensional measurements are latently present in most methods and instruments for measurements of physical-chemical parameters and properties of a nano-object, including measurements of its mechanical, optical, electrical, magnetic, acoustic characteristics.

At present, dimensional measurements at the nanoscale are performed with scanning electron microscopes (SEMs) and atomic force microscopes (AFMs). Standard test objects – relief measures located on a solid surface are used for SEM and AFM calibration. During the last few years such test objects were fabricated in Russia, and the following national written standards specifying fabrication and employment of these test objects for SEM and AFM calibration were developed:

1) GOST R 8.628–2007. Single crystal silicon nanometer range relief measure. Geometrical shapes, linear size and manufacturing material requirements.

2) GOST R 8.629–2007. Nanometer range relief measure with trapezoidal profile of elements. Method for verification.

3) GOST R 8.630–2007. Atomic force scanning probe measuring microscopes. Method for verification.

4) GOST R 8.631–2007. Scanning electron measuring microscopes. Method for verification.

5) GOST R 8.635–2007. Atomic force scanning probe microscopes. Method for calibration.

6) GOST R 8.636–2007. Scanning electron microscopes. Method for calibration.

7) GOST R 8.644–2008. Nanometer range relief measures with trapezoidal profile of elements. Methods for calibration.

The goal of the above standards is to achieve the traceability of the dimensional measurements at the nanoscale to the SI meter.

At present, the leading countries, which are paying the great attention and investing the proper funds into instrumental, analytical and technological infrastructure of nanotechnologies, consider the advanced development of nanometrology, and, in particular, dimensional measurements at the nanoscale as a high-priority task. Russia has a significant contribution into solving this basic measurement problem.