Scientists develop new technique for polishing surfaces at the nanoscale

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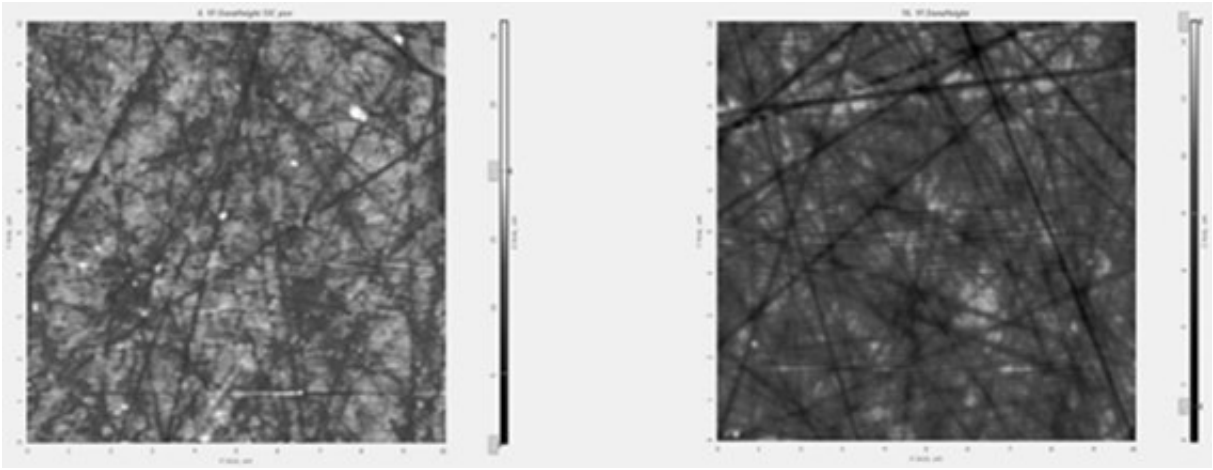

AFM of the surface of 6H-SiC. On the left: surface before planarization; on the right: after 15 minutes of radiation by ion-cluster beam. Credit: National Research Nuclear University

Currently, the main method of obtaining smooth surfaces in industry is chemical-mechanical or "wet" polishing. However, this has two disadvantages: Most methods leave a residual pattern at the scale of about 1 nm, as well as a defective near-surface layer. Moreover, removing imperfections from the surface of manufactured semiconductor plates, a process called "wet planarization," requires breaking vacuum conditions.

Using beams of accelerated cluster ions as an addition to the technology of chemical-mechanical planarization is a breakthrough in the development of micro- and nanoelectronics. Using cluster ions enlarges the sphere of objects for planarization—for example, the method has an advantage for the processing of superhard coatings like polycrystalline CVD diamond, silicone carbide, sapphire or quartz glass, because unlike machine processing, spillage properties do not depend on the target mechanical parameters, and the abrasion level is restricted to about 0.1 nm.

Employees of MEPhI Department of Condensed matter physics (№67) are close to a new planarization technology for silicone carbide material surfaces using accelerator cluster ions. During their work, scientists have researched the impact of ion-cluster radiation on the topology of plate surfaces of 6H-SiC crystals raised by the Lely method. Argon clusters, received in adiabatic gas expansion through a supersonic nozzle, were ionized and accelerated at a pressure of 30 KeV. The pressure in the working camera was 3×10^{-4} torr.

The surface relief pattern of 6H-SiC plates before and after the impact of the beam of cluster ions was studied using a scanning probe microscope called Solver Next. The size of the analysed area was 10×10 mkm. The quantity analysis of the topology of each sample was conducted for three different areas of its surface. Then the results of the surface roughness were averaged.

The results show significant smoothing of the relief of 6H-SiC plate surfaces after processing with a beam of cluster ions. Rq parameter is lowered 1.5 to two times. Thus, it has been proved in practice that gas cluster ions are an effective instrument of final smoothing for silicone carbide surfaces. However, it isn't possible to completely eliminate "diamond noise" (linearly structured faults), which would require enlargement of the radiation dose or energy of the cluster ions

interacting with the SiC surface.

The technique has applications in such areas as optoelectronics, optics and microelectronics.

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