FIRST INTERNATIONAL CONFERENCE ON ELECTRON MICROSCOPY OF NANOSTRUCTURES

ELMINA 2018

ПРВА МЕЂУНАРОДНА КОНФЕРЕНЦИЈА О ЕЛЕКТРОНСКОЈ МИКРОСКОПИЈИ НАНОСТРУКТУРА

August 27-29, 2018, Belgrade, Serbia
27–29. август 2018. Београд, Србија

FIRST INTERNATIONAL CONFERENCE

ELMINA 2018

PROGRAM

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BOOK OF ABSTRACTS

Rectorate of the University of Belgrade, Belgrade, Serbia
August 27-29, 2018
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Organized by:
Serbian Academy of Sciences and Arts and Faculty of Technology and Metallurgy, University of Belgrade

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FIRST INTERNATIONAL CONFERENCE
ELMINA 2018
Program and Book of Abstracts

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At the beginning we wish you all welcome to Belgrade and ELMINA2018 International Conference organized by the Serbian Academy of Sciences and Arts and the Faculty of Technology and Metallurgy, University of Belgrade. We are delighted to have such a distinguished lineup of plenary speakers who have agreed to accept an invitation from the Serbian Academy of Sciences and Arts to come to the first in a series of electron microscopy conferences: Electron Microscopy of Nanostructures, ELMINA2018. We will consider making it an annual event in Belgrade, due to this year's overwhelming response of invited speakers and young researchers. The scope of ELMINA2018 will be focused on electron microscopy, which provides structural, chemical and electronic information at atomic scale, applied to nanoscience and nanotechnology (physics, chemistry, materials science, earth and life sciences), as well as advances in experimental and theoretical approaches, essential for interpretation of experimental data and research guidance. It will highlight recent progress in instrumentation, imaging and data analysis, large data set handling, as well as time and environment dependent processes. The scientific program contains the following topics:

- Instrumentation and New Methods
- Diffraction and Crystallography
- HRTEM and Electron Holography
- Analytical Microscopy (EDS and EELS)
- Nanoscience and Nanotechnology
- Life Sciences

To put this Conference in proper prospective, we would like to remind you that everything related to nanoscience and nanotechnology started 30 to 40 years ago as a long term objective, and even then it was obvious that transmission electron microscopy (TEM) must play an important role, as it was the only method capable of analyzing objects at the nanometer scale. The reason was very simple - at that time, an electron microscope was the only instrument capable of detecting the location of atoms, making it today possible to control synthesis of objects at the nanoscale with atomic precision. Electron microscopy is also one of the most important drivers of development and innovation in the fields of nanoscience and nanotechnology relevant for many areas of research such as biology, medicine, physics, chemistry, etc. We are very proud that a large number of contributions came from young researchers and students which was one of the most important objectives of ELMINA2018, and which indicates the importance of electron microscopy in various research fields. We are happy to present this book, comprising of the Conference program and abstracts, which will be presented at ELMINA2018 International Conference. We wish you all a wonderful and enjoyable stay in Belgrade.

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Silicon Nanostructuring by Ag Ions Implantation Through Polystyrene Nanomask

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Mask-assisted ion beam processing of insulating substrates is a versatile tool for achieving nanopatterning of a material through the formation of ordered nanostructures. The possibility of producing self-assembled monolayers of silica or polystyrene (PS) nanospheres with size in the 100–1000 nm range on the substrate to be patterned is much simpler and cheaper alternative to conventional lithographic techniques, for the synthesis of 2D ordered arrays of nanostructures [1,2]. In some cases, after the nanosphere mask deposition, ion implantation can be used to selectively modify the substrate through the triangular holes left among adjacent spheres, providing that these are thick enough to stop incoming ions before reaching the substrate. In this work, we used ion implantation through self-assembled PS mask to directly and regularly modify the subsurface layer of silicon substrate with Ag ions.

The monocrystalline (100) p-type Si wafers with thicknesses of ~550 μm were covered with ~150 nm diameter PS spheres and implanted by singly charged Ag ions with energy of 60 keV and fluences of 1×10^{15}, 5×10^{15}, 1×10^{16} and 2×10^{16} ions/cm^2. The projected range of 60 keV Ag ions in polystyrene is 64 nm according to the SRIM-2008 [3] simulations, with the range straggling of 12 nm. Therefore, the ions hitting the center of PS spheres are expected to be completely stopped inside the spheres, and should penetrate the substrate only through the holes in the monolayer mask or at areas very close to the mask openings. Morphological and crystallographic analysis of the patterned Si after the mask removal was done by cross-sectional transmission electron microscopy (XTEM), using FEI Talos F200X microscope.

XTEM bright-field image of sample implanted to the dose of 1×10^{16} ions/cm^2 is presented in Fig. 1(a). Energy dispersive spectrometry microanalysis (in the inset) taken from the area given at the micrograph is characterized by a spectrum with Si and Ag peaks in the energy range of 1.5-3.5 keV. A large-scale area of the sample of several hundreds of nanometers indicates a periodic microstructure with the homogeneously arranged half-squared fragments. These fragments present the position of mask openings, where Ag ions penetrated into the Si substrate. They are roughly of same dimensions, with the width of about 190 nm and are arranged in a similar manner with 60-100 nm spacing in between. The micrograph in Fig. 1(b) presents XTEM bright-field image of the one of the irradiated Si regions with the surrounding non-irradiated substrate. One notes the presence of NPs below the top-surface of the implanted region of the Si substrate. Closer analysis of the substrate surface reveals that the Ag nanoparticles are situated only at the irradiated Si fragment, while beyond the edges of this region no Ag particles could be observed. The position of the implanted areas exhibit a weak contrast under the imaging conditions used, indicating that amorphisation of the Si substrate has occurred. High-resolution micrograph taken at the periphery of the amorphized Si region of the sample is given in the upper part in Fig. 1(c). As can be observed, the interface between a-Si and c-Si is characterized with the defect-rich zone (dark-contrast region), with a thickness of a few nanometers.

Figure 1(c) in the bottom shows high-resolution image of a typical Ag particle in the sample. It can be seen that the silver nanoparticle is crystalline in nature. The measured lattice spacing is 0.236 nm, which is in a good agreement with the theoretical value for cubic Ag [4].

It is demonstrated that the 60 keV Ag ions implantation into silicon through the nanomask consisting of ~150 nm diameter polystyrene spheres can be used for well-ordered nanostructuring of Si substrate. The Ag is implanted into the silicon at the openings between adjacent PS spheres, thus creating an array of amorphized Si regions with Ag nanoparticles formed. A major conclusion is that this technique may proof useful for nanostructuring surfaces in general, since the PS mask is fast to make and inexpensive while the implantation process is precisely controllable [5].

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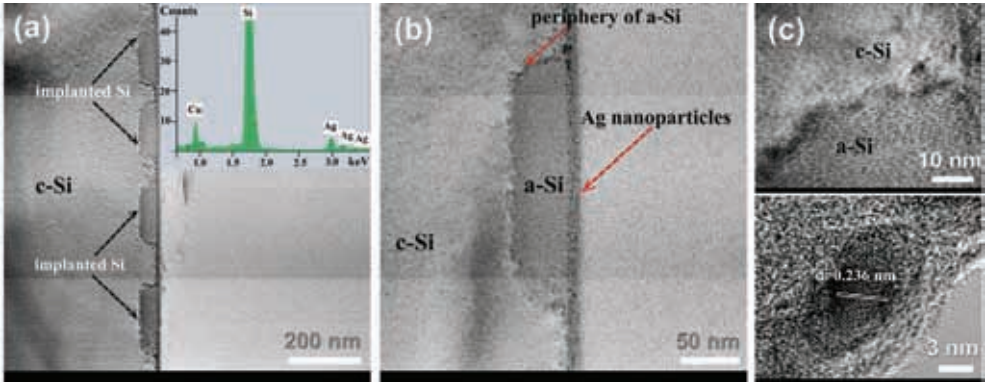

Figure 1. XTEM analysis of Si substrate irradiated to 1×10^{16} Ag/cm^2 through ~150 nm PS nanomask.

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