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Progressive materials and technologies

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Abstract

In modern materials science the main trends are represented by fabrication, characterization and application of materials and structures with dimensions in or near the nanometer range. In this frame, inorganic nanomaterials have been increasingly attracting the attention of scientists owing to their interesting electronic, optical, magnetic, thermal, mechanical and chemical properties, which are highly dependent on their size and shape. Such geometry-dependent characteristics are essential for their high impact on fundamental aspects as well as for the high potential in technology applications.

Keywords: scanning electron microscope, focused ion beam, back-scattered electrons

Introduction

Diminution of critical dimensions to nanometers area, increasing scale of integration and growing velocity and reliability of individual circuits and systems requires intensive research and development of new nanomaterials and nanostructures. Searching a new physical principles – their use will enable replacement or more precisely will enable proper integration of current technologies. Diminution of critical dimensions emphasises increased requirements concerning the diagnostic methods for electrophysical and optical characteristics of nanomaterials and nanostructures, as well as nanostructural surfaces. There is a need of using new or more precisely innovative methods, technics and proceedings with increased sensibility, spatial resolution, enhanced functionality and accuracy.

University Science Park University of Žilina (USP UNIZA) represents a unique center with the most progressive technological equipment. USP UNIZA will link the research with praxis so that the researchers in frame of USP are able to really commercialize the created solutions with innovative potential. The USP UNIZA divisions are focused on new materials and technologies development, information and communication technologies, transport systems and production systems.

Division of new progressive materials and technologies development

A part of research activities with a specific scope comprises the USP division of new progressive material and technologies development. It is concerning on the research and development of system applications based on optical fibres and photonic elements, methods and applications research in biomedicine engineering as well as unconventional drives and their components research. From the point of view of research and development system applications based on optical and photonic elements, the research in the field of analytic technics of materials, elements, sensors focused on a set of analytical techniques and instruments covering phase analysis of solid materials, laminated structures and surfaces – measurement and evaluation of surface morphology by scanning electron microscopy.

Rapid 3D optical diagnostics

Current microscopic equipment for a surface morphology display and measuring dimensions of micro and nano objects, using electronic focused beam, scanning the surface of the surveyed object. Electronic beam scans all over the sample surface and on the basic of signal gained from every point of the field, the resultant picture arises. The signal is gained by detection of secondary/back-scattered electrons generated/reflected by primary electron beam interaction with the sample. Raster principle currently allows scanning an electrophysical properties of

surfaces with resolution in nanometers or sub-nanometers area.

In frame of activity concerning the new advanced materials and technologies development a dual Scanning Electron Microscope (SEM) was chosen, the LYRA3 series of Tescan. A fully PC controlled SEM with Schottky field emission cathode in combination with gallium Focused Ion Beam (FIB) column and optionally with Gas Injection System (GIS). LYRA3 focused ion beam scanning electron microscope is determined for scanning the conductive and non-conductive preparates in high resolution. The ion column creates and positions a thin ion beam – the focused ion beam (FIB). This beam can be used for sample surface imaging or for creating local defined structures on the specimen. Modern optics enables unique live stereoscopic imaging using advanced 3D Beam Technology opens up the micro and nano-world for an amazing 3D experience and 3D navigation. The device enables working in high vacuum in regime secondary electrons and back-scattered electrons. Secondary electrons enhance topographic contrast contrary to material contrast of back-scattered electrons. Back-scattered electrons enhance material contrast of the sample. The LVSTD detector (Low Vacuum Secondary TESCAN Detector) is a detector of secondary electrons specially designed for a low vacuum mode. It is convenient for non-conductive samples investigation. Scanning electron microscope and double beam system SEM-FIB offer except for standard detectors reflecting the sample topography also integrate the spectrometers able to analyse chemical microanalysis of the surface (energy dispersive X-ray analysis) and detectors for obtaining crystallographic structure and orientation (electron backscattered diffraction). The spot size defines the imaging resolution and the edge sharpness of the created objects. Small spot size of the ion beam enables the creation of chemical maps of a sample with a high 2D resolution. The polycrystalline materials by using the electron backscattered diffraction detector creates a map displaying the orientation of the grains to the sample surface. Double beam system is suitable for the creating of 2D and 3D nanostructures to the examination of electrical and mechanical properties of materials.

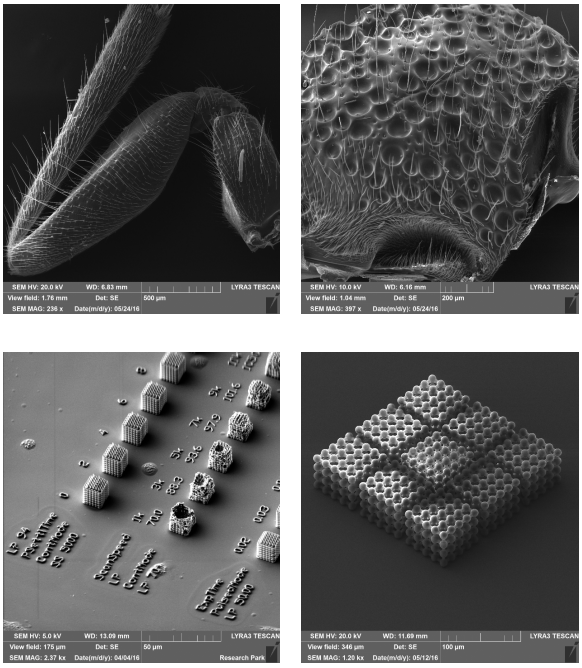

Figure 1 - SEM Applications

Conclusion

Acquisition of new equipment creates possibilities for characterization and diagnostics of new materials, nanostructures, nanostructured surfaces and elements prepared within research workplaces of the USP UNIZA. Gradually, creating the conditions to obtain new scientific knowledge about the properties and progressive materials and structures based on nanotechnology, which allows applications to new elements and systems.

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