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Characterization of Ti, TiO_2 and Au nanolayers implanted by highly charged Xe ions by application of synchrotron radiation based X-ray reflectometry and grazing incidence X-ray fluorescence

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The methods based on the application of X-rays play an important role among the techniques of studying the properties of materials. The most popular X-ray methods base on analysis of diffraction pattern and characteristic radiation emitted from the studied samples, giving information, for example, on chemical and elemental sample composition in wide range of compounds and elements. Additional application possibilities of analysis of flat surfaces or nanolayers are achieved by using incidence/emission low-angle geometry as in X-ray reflectometry (XRR) and grazing incidence X-ray fluorescence (GIXRF) [1-3]. These techniques provides determination of a layer density, thickness, roughness and depth-profiling of the elements.

In the presented studies XRR and GIXRF techniques were used for characterization of morphology of Ti, TiO_2 nanolayers (thickness of 25 nm, 50 nm and 75 nm) and Au nanolayers (5 nm, 10 nm, 25 nm, 50 nm, 100 nm) not implanted and implanted with Xe^{q+} ions, deposited on the different substrates (Si, SiO_2). Such characterization is important in studying of the nanolayers surface modifications caused by irradiation with highly charged ions, being of great importance for developing new technologies of nanomaterial production with properties not achievable by any other material processing methods [4].

The nanolayers were implanted with low-energy (~hundreds of keV) highly ionized Xe^{q+} (q = 25-40) ions at the Kielce EBIS facility (Jan Kochanowski University, Kielce, Poland) [5]. The XRR and GIXRF measurements were performed at Elettra Synchrotron X-ray fluorescence beamline, using synchrotron X-ray beam with energy of 6.0 keV.

The experimental results obtained with both techniques for Ti, TiO_2 and Au nanolayers, implanted with different incidence energies and charge states of the Xe^{q+} ions, as well as simulated theoretical XRR and GIXRF curves, will be presented and discussed. The main result is the observed differences in the samples morphology depending on the charge state of the Xe ions. The advantages and disadvantages of XRR an GIXRF technique, in the context of the nanolayer studies, will be also discussed.

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