DS 31: Application of Thin Films II

Time: Thursday 16:15–17:45 Location: GER 37

DS 31.1 Thu 16:15 GER 37

Development of multilayer optics for modern X-ray analytics — •Steffen Kroth[1], Jörg Wiesmann[1], Frank Hertlein[1], Carsten Michaelsen[1], and Michael Störmer[2] — [1]Incoatec GmbH, Max-Planck-Strasse 2, 21502 Geesthacht — [2]GKSS Forschungszentrum, Max-Planck-Strasse 1, 21502 Geesthacht

In this contribution, we give an overview on the state-of-the-art beam-shaping multilayer and total reflection optics for XRD in the lab and for synchrotron beamlines. Nowadays a large variety of 1D and 2D optics are available with optimized properties for the customer's applications. We explain the manufacturing process of multilayer and total reflection optics, summarize the different type of optics and give some examples of typical applications. The optics for lab-instrumentation consist of bent substrates with shape tolerances below 100nm, upon which multilayers are deposited with single layer thicknesses in the nm-range and up to several hundreds of layer pairs. Most multilayers were designed with lateral thickness gradients within 1% deviation of the ideal shape. This means that a deposition precision in the picometer range is needed. We use magnetron sputtering for deposition, optical profilometry in order to characterize the shape and X-ray reflectometry to characterize the multilayers. The microstructure is investigated by TEM. The beam parameters like monochromaticity, flux, brilliance and divergence demonstrate the quality of the multilayer optics for different lab applications.

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Effect of FEL induced ionization on X-ray reflectivity of multilayers — •Dmitriy Ksenzov, Souren Grigorian, and Ullrich Pietsch — University of Siegen, Siegen, Germany

The VUV-FEL in Hamburg (FLASH) emits short-pulse radiation with wavelengths from 6 to 30 nm and a pulse length of 10-50 fs. The FLASH wavelength allows x-ray diffraction experiments at periodical multilayer's structures acting as 1D crystal. The probe of depth selective interaction of the high-intense x-ray short pulse with these objects can be used to obtain information about possible electronic excitation and various recombination processes inside multilayers. As known from recent experiments at FLASH, the later ones are most likely using highly intense FEL radiation.

The ML reflectivity is analyzed for case of that the optical parameters are changing as function of the depth of the penetrating incident pulse into the multilayer. The response is studied for the model system La/B4C using two experimental conditions both at fixed incidence angle: 1) the energy of the incident pulses, E, coincides with the energy of the 1st order multilayer Bragg peak, E_B, of the reflection curve, and 2) the energy of incident pulse differs by a small dE from E_B. The ML response to a given sub-pulse differs for both conditions. However, there is a clear fingerprint of ionization for both conditions for the case that E is close to the K-absorption edge of B-atoms. Our results support respective efforts to measure the optical parameters of solids under high-intense FEL radiation.

DS 31.3 Thu 16:45 GER 37

Broadband multilayer soft X-ray mirrors for attosecond pulse formation at photon energies above 100 eV — •Michael Hofstetter[1], Andrew Aquila[2], Martin Schulze[3], Markus Fiess[3], Eleftherios Goulielmakis[3], Joerg Schuster[1], Martin Huth[4], Ferenc Krausz[3], and Ulf Kleineberg[1] — [1]LMU Physik — [2]CXRO — [3]MPQ — [4]LMU Chemie

We report on the development, fabrication and application of multilayer mirrors as broadband soft-X-ray optical components for the formation of attosecond (1 asec=10^{-18}s)pulses from high harmonic radiation. Until recently, attosecond physics was merely confined to the photon energy range below 100 eV due to the properties of Mo/Si multilayer and single isolated pulses of 80 asec pulse duration have been achieved [Goulielmakis et.al.]. For many applications, e.g. in the characterization of the photoemission dynamics from solid surfaces or the characterization of ultrafast surface plasmon dynamics in metallic nanostructures by attosecond pump-probe spectroscopy, higher photon energies are desirable to address deeper bound electronic core states or to increase the kinetic energy of the emitted photoelectrons [Cavalieri et.al., Stockman et.al.]. Here, we introduce new aperiodic broad bandwidth multilayer systems based on lanthanum (e.g. LaMo, LaB_4CMo, LaB_4C, MoB_4C),for the 100-190 eV photon energy range. Multilayer properties like interface roughness, interlayer formation and reflectivity are discussed. Finally, first applications for spectral filtering of the HHG comb above 100 eV are presented.

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Influence of nitrogen flow on structure and magnetic properties of magnetron-sputtered FeCo/TiN multilayer films — •Christian Klever and Klaus Seemann — Forschungszentrum Karlsruhe, Institute of Materials Research I, D-76344 Eggenstein-Leopoldshafen, Germany

Soft magnetic thin films with appropriate high frequency properties are interesting for applications, e. g., as core material for microinductors and for magnetoelastic sensors/actuators. For the use in such devices, tailoring of the magnetic film properties (e. g. saturation magnetization M_S, coercitive field H_C, anisotropy field H_K) is necessary.

In this study, multilayer films consisting of FeCo as the magnetic constituent and TiN as diffusion barrier are developed. The films are grown by sequential magnetron sputter deposition using a FeCo and a TiN target in an Ar atmosphere with an additional N_2 flow between 0 and 5 % of the total gas flow. The films are annealed *ex-situ* in a static magnetic field. The static and dynamic macroscopic magnetic properties of the films are determined by means of a vibrating sample magnetometer and a strip-line permeameter connected to a vector network analyzer, respectively. The microstructure and constitution of the films are examined by XRD, XRR, TEM and AES depth profiling.

It is shown that films with a coercitive field below 0.2 mT and a sufficient high frequency response can be produced by defining appropriate growth and film annealing conditions. Furthermore, the correlation between the nanoscale coating architecture, the films' microstructure and its macroscopic magnetic properties is presented.

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Development of higher m supermirrors — •valicu roxana and borchert gunther — FRM II

Supermirrors are important components of neutron guides used for performing neutron scattering experiments for from the reactor core to the instruments, where the background is low enough to permit measurements of even week signals. We will present the methods used at our facility to produce supermirros, the trials that we have made to increase the performances of supermirrors and the results obtained from the neutron reflectivity measurements. Using the Hayter and Mook algorithm we have simulated sequences with increasing number of Ni and Ti layers and we have achieved a neutron reflectivity of around 84% for m equal to 3. The next step in improving our facility was to try the reactive sputtering process (by using N and air as sputter gas together with Ar) in order to achieve the deposition of more layers and therefore of higher m-values. X-ray and neutron reflectivity measurements as well as X-ray diffraction and profilometry for the stress analysis were performed in order to determine the proper parameters for the sputtering of Ni. As a consequence we have produced supermirrors with higher m values that were not able to achieve without the reactive sputtering of Ni. Neutron reflectivity measurements for the produced supermirrors show promising results.

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Nanostructured magnetic FeCo/TiN thin film composites — •Hayo Brunken, Alan Savan, and Alfred Ludwig — Institute of Materials, Faculty of Mechanical Engineering, Ruhr-University Bochum, 44780 Bochum, Germany

In this study, magnetic thin film composites consisting of a nanostructured wear-resistance-coating and a nanogranular ferromagnetic component are presented. The magnetic thin film composites were prepared from a precursor multilayer thin film (FeCo/Ti) using magnetron sputtering. The multilayer precursor structure was deposited as a continuous composition spread on Si/SiO_2 substrates and transformed into a multiphase microstructure by thermal activation (typically 850°C, 1 h) in a reactive atmosphere (N_2). The characterization of the annealed thin films' microstructure using X-ray diffraction indicated a FeCo (100) phase and the formation of a TiN (111) phase. Furthermore, it was found that the films show a coercivity below 2 mT and a high saturation magnetization. Funding by the DFG via

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