Ion beam sputter deposition of carbon-based multilayers for x-ray and neutron reflectors

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Ion beam sputter deposition (IBSD) has been used for the production of high performance x-ray optical multilayers for many years. In comparison to other vacuum deposition methods it has various advantages, e.g. rather high and adjustable particle energies of the material flux and stable and reproducible process control during multilayer growth.
For x-ray optical applications carbon is an interesting material because of its low absorption coefficient over a wide spectral range and the opportunity, to deposit C-layers with different modifications, i.e. different optical properties. Furthermore the deposition of carbon/carbon multilayers with alternating high and low dense layers offers the possibility to produce x-ray optical mirrors with both, high resolution and high reflectance. For x-ray optical multilayers carbon films with smooth interfaces, low surface roughness and low intermixing zones between the adjacent layers have to be deposited, which is the major challenge for the deposition technique used.
Secondly, hydrogen free diamond-like carbon (DLC) is a promising coating material for applications with ultracold neutrons. It can potentially replace the toxic beryllium which has been widely used for storage and guidance of such neutrons. Carbon films with high sp3-content and smooth surfaces on large areas (typ. several 100 cm^2) are required for these coatings.

We present our newly installed large area IBSD facility and results of multilayer deposition experiments for various carbon-based systems and applications, e.g. Ni/C and Ni/B4C mirrors for x-ray diffractometry, Cr/C monochromators for x-ray fluorescence analysis and DLC films for neutron optics. Important optical properties like film density, surface roughness or reflectance and spectral resolution are discussed as well as deposition characteristics like reproducibility and homogeneity of the deposited (multi-)layers.