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Multilayer-based Soft X-Ray Polarimetry

F. Schäfers

BESSY GmbH, Albert Einstein Strasse 15, D-12489 Berlin

In order to make a complete polarization analysis of light, distinguishing between linear, circular and unpolarized components, i.e. all 4 Stokes parameters requires both a polarizer to introduce a phase shift between the two electric field components and an analyzer which transmits preferentially only one particular linearly polarized component. Such optical elements are common in the visible, (E)UV and the hard x-ray range. For the soft x-ray range new optics on the basis of multilayers operated in transmission and in reflection have been developed in the last years.

In order to make use of the polarizing elements a novel high precision UHV-polarimeter chamber to incorporate a variety of optical elements will be presented. This chamber can be used as a selfcalibrating polarization-detector or, by removal of either the polarizer or the analyzer, as a versatile reflectometer / ellipsometer. Thus any new kind of optical elements can be characterized with respect to reflection or transmission measurements in s- and p-polarization geometry and, for transmitting optics with respect to phase shifting properties. In-vacuum electromagnetic coils which allow for an in-situ magnetisation of samples enable magneto-optical effects like MCD, Faraday-effect and resonant magnetic scattering to be studied.

The polarization properties of Mo/Si, Cr/C, Cr/Sc and Ni/Ti multilayers to be used in this polarimeter have been investigated theoretically and experimentally. In the soft X-ray range, close to the 2p edges of Sc, Ti and Cr, a resonantly enhanced phase retardation of the transmission polarizers of up to 30^{o} has been measured. With these newly developed optical elements the complete polarization analysis of soft X-ray synchrotron radiation could be extended to the water window range between 300 eV and 600 eV. For higher energies new methods for polarization monitoring and manipulation based on magnetic absorption at the 2p edges of Fe, Co and Ni will also be presented.

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