Theory and practice of soft x-ray transmission multilayer polarizers

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In order to unambiguously determine the Stokes parameters of a light beam one needs to use a polarizer which introduces some phase retardation into one of the orthogonal components of the electromagnetic wave. Only this will allow to distinguish completely unpolarized from circular polarized radiation. The possibilities to achieve in the soft x-ray range some phase retardation and ideally the desirable 90 degree phase shift will be discussed. While any significant phase retardation of 5 to 10 degrees will already allow the use of such objects for polarization analysis, only a 90 degree phase shift will permit to convert linearly polarized into circularly polarized light, a very important tool e.g. for the investigation of magnetic materials. Indeed up to about 100 eV photon energy phase shifts up to 90 degrees are possible, however, on the expense of small system efficiencies. The possibility of phase retarders for photon energies above 100 eV will be discussed in detail in this seminar. The most promising devices for this range are transmission multilayer filters. Theoretical studies on their properties will be compared to experimental data. Efficient transmission multilayers need to be operated close to the Brewster angle, which for soft x-rays is close to 45 degrees angle of incidence. Under this condition the multilayer period needs to be about 2 nm for photon energies around 400 eV and only 1 nm for energies in the range 800 eV, where the L-edges of the magnetic materials are found. State-of-the-art production techniques permit to fabricate objects with sufficient phase retardation for the first energy but not for the latter one. Consequently this seminar will concentrate onto the possibilities for transmission multilayer phase shifters for operation below and in the water window.