Diffractive nano-optics and their use for X-ray synchrotron radiation

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The current intense interest in extreme ultraviolet and x-ray microscopy is mainly due to the availability of a nearly ideal optical source for nano-optics based on diffraction, that is, a source with low divergence whose wavelength can be tuned over a range of several keV and whose spectrum can be monochromatised with a band pass $\Delta\lambda/\lambda$ of less than 10^{-4}. Synchrotrons of the latest generation and free electron lasers (in the near future) are devices that produce x-rays with these characteristics. Zone plate, that can be now considered a well established focusing element for x-rays, was invented more than hundred years ago but due to technological difficulties, they have been implemented only in the last three or two decades.
In this presentation we show that it is possible to design, fabricate and easily use new optical elements that, beyond focusing, can perform new optical functions. In particular, the intensity of light in the space beyond the optical elements can be redistributed with almost complete freedom. In other words, already available extreme ultraviolet and x-ray sources are suitable as ideal sources for diffractive optical elements designed to perform new optical functions useful in scanning and transmission X-ray microscopes. Finally, results on the possibility of combining X-ray beams with other optical tools in different wavelength regime such as optical tweezers will be presented.