Imaging nanomagnetism with magnetic soft X-ray microscopy

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The grand challenge to modern magnetic microscopies is to provide both spatial resolution in the nanometer regime, a time resolution down to the fs scale and elemental specificity which allows to study static magnetic properties and behaviour in novel multicomponent and multifunctional magnetic nanostructures and their ultrafast spin dynamics which is both fundamentally and technologically of paramount interest.
Magnetic soft X-ray microscopy combines X-ray magnetic circular dichroism (X-MCD) as element specific magnetic contrast mechanism with high spatial and temporal resolution. Fresnel zone plates are used as X-ray optical elements. They can be fabricated by state-of-the-art nanotechnological lithography and provide a spatial resolution down to currently <15nm [1] which approaches fundamental magnetic length scales such as the grain size [2] and magnetic exchange lengths. As a pure photon-in/photon-out technique X-ray images can be recorded in external magnetic fields giving access to study magnetization reversal phenomena on the nanoscale. Utilizing the inherent time structure of current synchrotron sources fast magnetization dynamics with 70ps time resolution, imited by the lengths of the electron bunches, can be performed within a stroboscopic pump-probe scheme [3].
I will review recent achievements of magnetic soft X-ray microscopy by selected examples on magnetic multilayers and nanostructured systems where both classical Oersted fields as well as spin torque phenomena are used to manipulate the magnetisation [4] and its spin dynamics.
Future perspectives of magnetic soft X-ray microscopy aiming for <10nm spatial and fs time resolution will be discussed.

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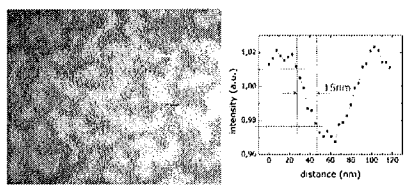

Magnetic domain structure in a nanogranular CoCrPt thin film imaged with 15nm spatial resolution X-ray optics.. TEM analysis yields an average grain size of 20nm.[2].

References

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