Master position:

Application of Phase Gratings and Focusing Optics for Coherent Diffractive Imaging

Advertising institutes: Chair for Experimental Physics of Extreme Ultraviolet Radiation, Aachen and Peter Grünberg Institute 9, Forschungszentrum Jülich

We offer a master position in the field of Coherent Diffractive Imaging (CDI) employing a plasma-based light source in the extreme ultraviolet (EUV). The project goal is to select different wavelengths from the multi-wavelength EUV spectrum and to increase the light intensity on the sample.

Background:

Coherent Diffractive Imaging (CDI) is a lensless microscopy technique, which gained a lot of attention during recent decade. In (transmission) CDI the sample is illuminated by a sufficiently coherent light beam and the diffraction pattern of which is recorded behind the sample. Then, the diffraction pattern is processed by a reconstruction algorithm iterating between real and Fourier space, which iteratively searches for an object with a similar diffraction pattern as the recorded pattern. This phase reconstruction recovers an image of the sample and electromagnetic field behind the sample (amplitude and phase).
CDI in the EUV spectral range exhibits high material contrast because many radiation adsorption edges of common materials are in this photon energy range. The low radiation dose sufficient for CDI in the EUV region makes it also attractive for biology imaging, where radiation damage is a limiting factor. From the technical perspective, CDI employs a lensless setup, which reduces cost and time for adjustment.
Few years ago, high-resolution CDI was only applicable at large scale facilities, i.e. at synchrotrons or at free electron lasers, due to their high brightness and high coherence in the EUV and X-ray spectral range. Recently, some progress was made in utilizing high harmonics from femtosecond lasers and EUV emission lines from capillary gas discharge sources. The EUV gas-discharge sources used in our group developed by the Fraunhofer ILT, enable for the first time for non-experts to utilize EUV light for applications. In fact, this source already paved the way for a large variety of techniques previously available only at large scale facilities (EUV-Lithography, EUV-Reflectometry, Microscopy, Scatterometry, etc. ,…) to be used in small-scale laboratories.

Project description:

The current CDI setup uses an aperture to ensure spatial coherence, multilayer Bragg mirror for spectral filtering and a CCD detector to record the diffraction pattern. As all components are in or attached to vacuum elements, distance variation is limited or requires a modifications of the setup.

The task for this project is to include a focusing optic (i.e. a toroidal gold mirror) into the CDI setup to compensate these distance limitation by variation of the focus point distance to the sample. Crucial parameter for this design approach is the spatial and temporal coherence, which together with the beam intensity and profile has to be measured at different distances from the source. For characterization of the coherence, double slit measurements will be performed.

Furthermore, the student will evaluate the possibility to use phase gratings as an alternative for the Bragg mirrors in combination with the focusing optics. These phase gratings are already fabricated, but also new gratings will

be produced. (Phase) Gratings are chosen due to their wavelength selectivity, adjustable spectral resolution and diffraction efficiency.

Finally, the project can show the feasibility of CDI experiments with phase gratings and toroidal mirrors in combination with the EUV gas-discharge-source.

Your profile:

- Bachelor in physics, engineering or related sciences
- passion for experimental work
- beneficial: knowledge in Matlab and/ or Python programming

We offer:

- leading-edge research
- professional support and supervision
- pleasant working atmosphere
- international cooperation

Contact:

For further information about other applications and source development: *www.euv.rwth-aachen.de*

The project can be adjusted with respect to your interest.

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