EXTATIC

Extreme-ultraviolet and X-ray Training in Advanced Technologies for Interdisciplinary Cooperation

EXTATIC Project Proposal 2016

Project Title	Applications of soft X-ray coherent imaging
Home University	University of Southampton
Home University Supervisor	Dr. W.S. Brocklesby
Host University	RWTH Aachen
Host University Supervisor	Prof. Larissa Juschkin
Third University	
Third Supervisor	
Associated Partner(s)	
Associated Partner Supervisor(s)	
Project Outline (max 250 words)	Soft X-rays provide an exciting new area for imaging, as coherent imaging using lab-based sources replaces traditional synchrotron-based techniques. The high resolution and novel contrast mechanisms allow for new applications in industry and in medicine. This project will explore applications of coherent diffractive imaging which will include • **Imaging of lithography masks for next-generation silicon chip fabrication**: Smaller features in next-generation memory and processors will require the use of 13.5nm light to create the features. Examination of masks for 13.5nm lithography requires the use of soft X-ray microscopy to characterize defects. • **Biomedical imaging**: the increased resolution and sample transmission available as the wavelength of light used for imaging goes toward 4nm will bring about a transformation of biomedical imaging. Present electron microscopy techniques cannot penetrate through cells; soft X-ray imaging will allow imaging within cells in conditions close to those in nature. • **Pump-probe imaging**: the femtosecond pulses produced by high harmonic generation will allow measurement of atomic motion with length scales of tens of nanometres and timescales of tens of femtoseconds or faster. These areas require a coherent source of soft X-rays. Within the project, several sources will be used, including sources based on femtosecond lasers & high harmonic generation (Southampton) and high-flux sources based on gas discharges (Aachen). The project will give the candidate training in the use of femtosecond lasers and in X-ray optics and techniques, and a thorough introduction into modern algorithmic image processing. We envisage significant contact with end users in industry and in biomedical research.
Relevant Reference(s)	Bergh, M., Huldt, G., Tîmneanu, N., Maia, F. R. N. C. & Hajdu, J. Feasibility of imaging living cells at subnanometer resolutions by ultrafast X-ray diffraction. Q. Rev. Biophys. 41, 181–204 (2008).

	Juschkin, L., Freiberger, R. & Bergmann, K. EUV microscopy for defect inspection by dark-field mapping and zone plate zooming. J. Phys. Conf. Ser. 186, 012030 (2009). Butcher, T. J. et al. Bright extreme-ultraviolet high-order-harmonic radiation from optimized pulse compression in short hollow waveguides. Phys. Rev. A 87, 043822 (2013). Juschkin L., Imaging with plasma based extreme ultraviolet sources. Invited book contr. to Short-Wavelength Imaging and Spectroscopy Sources, ed. by D. Bleiner, Proc. SPIE 8678F (2012).
Lead University Profile	**Southampton:** URL: http://www.orc.soton.ac.uk/xray.html Bill Brocklesby leads a group working on generation and applications of coherent VUV and EUV light by high harmonic generation. The work ranges from development of high intensity, high average power pulsed fibre lasers, through simulation and development of capillary-based XUV HHG sources, to the use of HHG sources in coherent imaging, and spectroscopy in time and frequency domains. The group is multidisciplinary, with members from Physics, Optoelectronics, Chemistry, and Life Sciences. The Southampton group comprises 3 academic faculty and 5 research students.