

PROCEEDINGS OF SPIE

# ***X-Ray Lasers and Coherent X-Ray Sources: Development and Applications X***

**Annie Klisnick  
Carmen S. Menoni**  
*Editors*

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## Introduction

The X-ray Lasers and Coherent X-ray Sources: Development and Applications X conference held 27–29 August 2013 in San Diego, California, provided a premier forum for the presentation and discussion of the most recent developments in the generation of intense x-rays from plasma-based x-ray lasers, fourth generation accelerator-based sources, and high-order harmonic (HOH) generation. The unique and complimentary characteristics of these sources in combination with novel optics are making possible applications and fundamental studies ranging from nano-imaging and patterning to the study of laser/materials interactions to novel spectroscopies.

Work presented at the conference in plasma based x-ray lasers showed these table-top sources have achieved high average power, a fraction of a milliwatt at sub-20-nm wavelength, and laser emission down to 7.3 nm with substantially lower pump energies. Seeding of x-ray laser amplifiers with HOH is paving the way to realize a peak brightness that approaches that of free electron lasers with fully phase-coherent x-ray laser pulses. New modeling results show that sub-100 femtosecond pulses with tens of microjoule energies would be possible to achieve from seeded solid x-ray amplifiers. Different new approaches for HOH source development were reported. The generation of keV HOH was demonstrated using mid-infrared pump lasers in high pressure gas capillaries and at relativistic laser intensities into a gas jet respectively. Already established TW laser facilities and new ones in construction will provide critical infrastructure to advance plasma based x-ray lasers and HOH. Work on free electron laser (FEL) sources reported fully coherent x-ray emission in the 20-100 eV range at Fermi@Elettra FEL, with the first implementation of a double-cascade seeding technique. Works on FELs operating in the keV range focused on the characterization of the laser pulse duration and on the future implementation of a self-seeding technique to achieve full temporal coherence.

X-ray optics and x-ray laser applications were discussed in several sessions. Important advances have been achieved in the mitigation of laser-induced-corrosion of multilayer optics for the 20-60 eV range. Key applications of mature x-ray plasma based sources in microscopy, nanopatterning, and spectroscopy have been demonstrated. In the technologically relevant 13.5-nm wavelength range, a HOH scatterometer microscope capable to identify 20-nm defects on extreme ultraviolet lithography masks was demonstrated, complementing synchrotron and plasma x-ray lasers defect inspection microscopes. X-ray sources also enabled the investigation of femtosecond laser ablation by time resolved reflectivity and the implementation of novel absorption, mass, and nuclear spectroscopies. The interaction of intense x-ray pulses with gas phase molecules and solids was covered in several papers describing modeling and experiments.

We gratefully acknowledge the continued support of SPIE for the field of x-ray lasers. We thank SPIE for the outstanding organization of the conference at all stages as well as the considerable efforts of the staff towards the publication of the proceedings volume. We would like to thank the program committee for their support and guidance and to the session chairs for their help in the running of the conference. Finally we thank the many participants for their high quality scientific contributions to the 2013 meeting.

**Annie Klisnick**  
**Carmen S. Menoni**