The XUV band, a region of light spanning the wavelength range of 5 – 200 nm, is located between the Ultraviolet and X-ray regions of the electromagnetic spectrum. It is further divided into a 100 – 200 nm region called the Vacuum Ultraviolet (VUV), and a 5 – 100 nm region called the Extreme Ultraviolet (EUV). Applications of this light have been slow to develop due to the lack of suitable sources, efficient optics, and sensitive detectors. Recently, many industries such as the semiconductor manufacturing industry, medical surgery, micromachining, microscopy, and spectroscopy have begun to benefit from the short wavelengths and the high photon energies of this light. At present, the semiconductor chip industry is the primary reason for the investment in, and development of, XUV sources, optics, and detectors.

The demand for high power EUV light sources at 13.5 nm wavelength is driven by the development of the next generation of semiconductor lithography tools. The development of these tools enables the continued reduction in size, and the increase in transistor density of semiconductor devices on a single chip. Further development and investigation of laser produced plasma EUV light sources is necessary to increase the average optical power and reliability. This will lead to an increase in the speed of EUV lithographic processes, which are necessary for future generations of advanced chip design, and high volume semiconductor manufacturing.

Micromachining, lithography, and microscopy benefit from improvements in resolution due to the shorter wavelengths of light in the VUV band. In order to provide adequate illumination for these applications, sources are required which are brighter and have higher average power. Laser produced plasma (LPP) VUV light sources are used extensively for lithography and defect detection in semiconductor manufacturing. Reductions in the wavelength and increases in the average power will increase the rate and yield of chip manufacture, as well as reduce the costs of semiconductor manufacture.

The work presented in this dissertation describes the development of two laser plasma source facilities in the Laser Plasma Laboratory at UCF, which were designed to investigate EUV and VUV laser plasma sources. The HP-EUV-Facility was developed to optimize and demonstrate a high power 13.5 nm EUV LPP source. This facility provides high resolution spectroscopy across 10.5 – 20 nm, and absolute energy measurement of 13.5 nm +/- 2% in 2pi sr. The VUV-MS-Facility was developed to investigate VUV emission characteristics of laser plasmas of various target geometries and chemistries. This facility provides absolute calibrated emission spectrum for the 124 – 250 nm wavelength range, in addition to, at wavelength plasma imaging. Calibrated emission spectrum, in-band power, and conversion efficiency are presented in this work for gas targets of Argon, Krypton, and Xenon and solid targets of Silicon, Copper, Molybdenum, Indium, Tantalum, Tin, and Zinc, across the laser intensity range of 8.0x10^6 – 3.2x10^12 W/cm^2.

Major: Electrical Engineering

Educational Career:
Bachelor's of Electrical Engineering, BS, 2007, University of Central Florida
Master's of Electrica Engineering, MS, 2010, University of Central Florida
Master's of Physics - Photonics, MS, 2011, Friedrich Schiller University of Jena

Committee in Charge:
Martin Richardson, Chair, Electrical & Computer Engineering
Kalpathy Sundaram, Electrical & Computer Engineering
Reza Abdolvand, Electrical & Computer Engineering
Bhimsen Shivamoggi, Mathematics
Matthieu Baudelet, Chemistry
Approved for distribution by Martin Richardson, Committee Chair, on June 21, 2017.

The public is welcome to attend.