DOE Plasma Science Center

Visiting Graduate Student/Post Doctoral Researcher Fellowship Report

Date:	09/16/14	
Name:	Jim Franek, Sam Nogami	
Institution	West Virginia University	
Email:	jfranek@mix.wvu.edu; snogami@mix.wvu.edu	
Advisor:	Mark Koepke	
Advisor email:	Mark.Koepke@mail.wvu.edu	
Institution to Visit:	Sandia National Laboratories	
Host:	Ed Barnat	
Host email:	evbarna@sandia.gov	
Title of Project:	Correlating metastable-atom density, reduced electric field, and electron energy distribution in moderate-pressure argon discharges	
Dates of Visit:	**Start:** 7/13/14	**End:** 8/13/14

Description of Project and Research Conducted:

The purpose of the collaborative effort between West Virginia University (Mark Koepke, Jim Franek, Sam Nogami, and Vladimir Demidov), Wright-Patterson Air Force Base (Vladimir Demidov) and Sandia National Laboratories (Ed Barnat) was to make Langmuir Probe, Optical Emission, Microwave Cavity Resonance and Laser-Diode Adsorption measurements in the transient phase of an argon positive-column discharge to further test, validate, and expand upon the 420.1/419.8 line ratio technique proposed by S.F. Adams et al. (Phys. Plasmas 19, 023510 2012). These measurements were performed during Jim and Sam's second one-month visit and the data collected will be analyzed in the following months.

The interaction made possible by the LTPSC brought together two capabilities that allowed for the unique and complete testing and development of the line ratio technique that would only be possible through the on-site visit at Sandia National Labs. Specifically, Ed Barnat provided a pulsed hollow cathode discharge and the diagnostic equipment necessary to study the transient behavior of the plasma. Jim provided optical emission and laser diode adsorption measurements while Sam provided resonant microwave cavity measurements. Together, these measurements formed a complete data set capable of fully validating and developing the line-ratio method. The presence of two visiting students was vital in this effort as it increased the efficiency of data collection process and led to the students' deeper understanding of the physics of the experiment. Ed and Mark both contributed to the construction of the Langmuir probe and its driving circuit while Vladimir provided his expertise in the collisional radiative model which helped set the scope of the experiments performed and expanded knowledge base of all parties in the collaboration.

The primary accomplishment of the first two weeks was the construction of a Langmuir probe capable of producing a reliable current-voltage characteristic when immersed in the plasma, particularly, the Langmuir probe and its operation must not perturb the surrounding plasma. The current-voltage characteristic will be used to extract the electron energy distribution function (EEDF) that will be used in conjunction with published electron-excitation cross-sections to determine the corresponding excitation rate constants in the extended corona model.

Measurements of metastable density, electron density and reduced electric field will also be used with the results of Adams et al. to predict these rate constants as well. Both of these rate constants will be used to predict the ratio of the argon 420.1/419.8 emission lines and comparison with the observed data will be made.

This second month of the collaborative effort also focused on applying the line-ratio method of Adams et al. to discharges at higher pressure, approaching ten percent of atmospheric pressure. A potential alternative being studied is the utility of the 425.9nm emission line. It has been reported by Boffard et al. (J. Phys. D. **37** R143–R161 2004) that the 425.9 emission line has a similar optical emission cross section with less pressure dependence than the 419.8nm emission line, and thus may be more appropriate for a diagnostic technique applicable to a larger range of pressures. A comparison between the intensity of the 419.8nm emission and the 425.9nm emission suggests a 425.9/420.1 emission ratio may be useful as a pressure-independent diagnostic.