DOE Plasma Science Center

Visiting Graduate Student/Post-Doctoral Researcher Fellowship Report

Title of Project:	**Study of Ar-H_2O nanosecond pulsed discharge**	
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Institution Visited:	University of Michigan Ann Arbor	
Host:	Prof. Mark J. Kushner	
Host email:	mjkush@umich.edu	
Dates of Visit:	**Start:1/6/2016**	**End:1/8/2016**

I. Description and Importance of Research Issues Investigated During Visit

While water containing discharges have numerous applications, the kinetics of water containing plasmas at atmospheric pressure is poorly understood. One of my research goals is to perform chemical kinetic studies of discharge containing water through laser diagnostics and compare them with 0-D chemical kinetic models.

The purpose of the research visit was to learn to use the software of the 0D plasma kinetics model, GLOBAL_KIN developed by Professor Mark Kushner's group.

While we have several experiments we would like to complement with kinetics modelling, we currently focused our efforts on one case study: an argon-water atmospheric pressure nanosecond pulsed plasma jet. We have experimental data on the electron density, gas temperature, H and OH density for this plasma jet which makes it an ideal test case to be compared with model prediction. The collaboration allows me to use the well validated GLOBAL_KIN code to start detailed chemical kinetic studies.

I visited the Kushner group for three days. GLOBAL_KIN model was installed on my computer. A test case, which is a simplified version of the pulsed argon water is modeled with the help of Professor Kushner's group. During the preliminary testing, I had many further interactions with the Kushner group and refinement of the model is still ongoing.

The research visit enabled us to start a collaboration between the group of professor Kushner's and our group which combines unique expertise in diagnostics and modelling. This collaboration uniquely provides me an opportunity to increase the physical insights gained by experiments through modelling. In addition, it allows us to investigate further the chemical reaction set for water containing plasmas and validate and improve it.

II. Discussion of Research Outcomes and Findings Resulting from Visit

The argon water plasma jet has the following experiment conditions: The power is supplied by a pulse generator (PVX-4110) with a pulsed output of voltage 4.7kV and 200ns FWHM. The power deposition is measured by high voltage probe and Rogowski coil mounted before and after the plasma jet. A 1.34 slm flow rate air with 0.26% water admixed flows through the inner gas tube where high voltage electrode is mounted. 2slm dry argon flows through the outer tube acting as shielding gas to prevent surrounding air diffusing into the core flow region. Fig. 1 shows the preliminary comparison of modeled and experimental H and OH density as a function of time. From the figure, we can conclude that the absolute value of models prediction and experiment measurement are in reasonable agreement. The model predicts the H density profile quite well although a larger time delay in H production is found experimentally. The OH density profile however is significantly narrower compared to the experimental data. The OH density calibration needs to be verified. In addition, the chemical kinetics set should be evaluated. The model predicts an important amount of vibrational excitation which could play a role in the OH kinetics. This is further investigated as part of the continuing collaborative effort between the group of professor Kushner's and Bruggeman's.

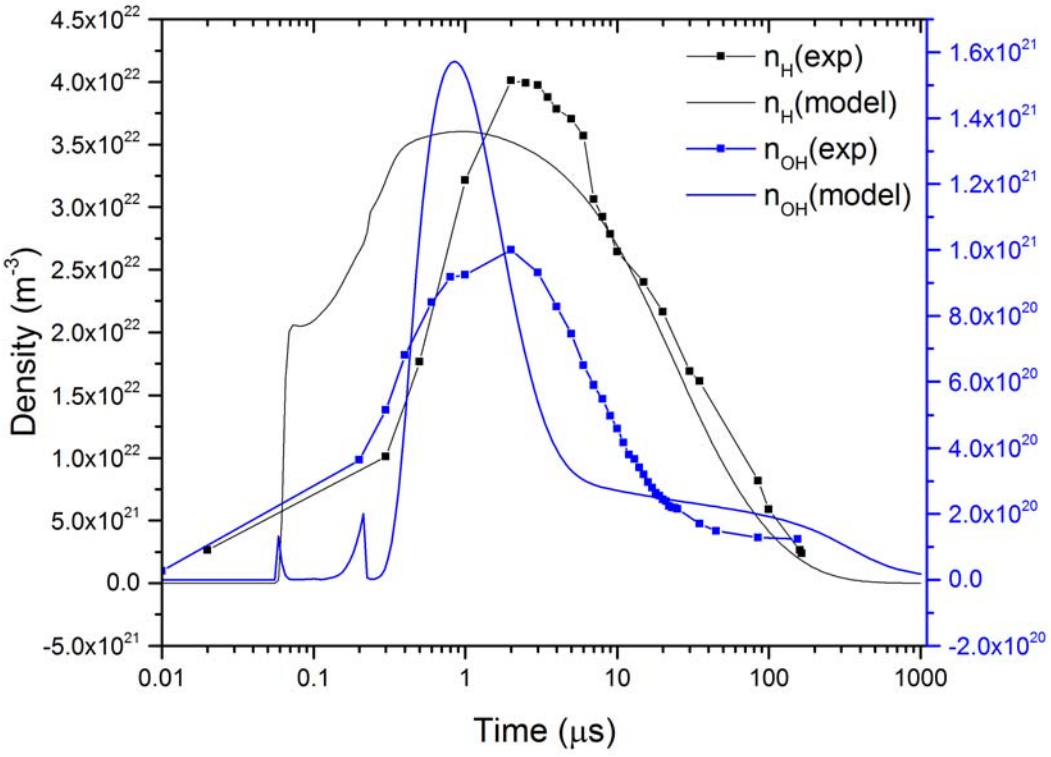

Fig. 1 Comparison of H and OH absolute density between model and experiment

III. Follow-up to Visit

Resolving the discrepancy between model and experiment is part of the continuing collaborative effort between the groups of professor Kushner's and Bruggeman's.

We expect to publish one paper about the described comparative study.

We also plan to use the GLOBAL_KIN to model chemical reactions in pure water discharges and air-methane discharges. This will lead to several more publications in the future.