

Final Report

RUI: Structure and Behavior of RF-Driven Plasma Filaments in High-Pressure Gases

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Project Director: Dr. Nirmol Podder

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Recipient Organization: University Auxiliary and Research Services Corporation (UARSC) at California State University, San Marcos (CSUSM)

Amount of unexpended funds at the end of the current budget period (if any): **0**

Summary of Results/Significant Findings

Findings from our three-year study significantly extend the initial qualitative work on this system by Campanell et al. [1]. Voltage variables effecting filament structure, propagation, and evolution have been elucidated with results summarized and recently submitted for publication in *Physics of Plasmas* [2] (submitted Nov. 2014); the manuscript abstract is as follows: “The filamentary discharge seen within commercial plasma globes is commonly enjoyed yet not well understood. Here we investigate filament properties in a plasma globe using a variable high voltage amplifier. We find that increasing voltage magnitude increases the number of filaments while leaving their individual morphology basically unchanged. Voltage frequency also affects filament population but more significantly changes individual filament morphology, with more diffuse filaments seen at lower frequencies. Voltage polarity is observed to be important, especially at lower frequencies, where for negative polarities the discharge is more diffuse, not filamentary. At late stages of the discharge novel circular structures appear and expand on the outer glass boundaries. We discuss the physics of these observations and their relation to similar discharges that can be found within industry and atmospheres.”

The P.I. contributed research highlights on this project at the annual APS-DPP meetings [3] (2012, 2013) as well as at the 12th International IPELS workshop (Hakuba, Japan, 2013). Undergraduates have been, and continue to be, central to both research and outreach efforts. Four different undergraduates were employed on the project during this period, mostly during the summer. One of these students, Mr. Gary Simmons, presented a poster on the plasma globe at the 2013 APS-DPP meeting [4]. The PI and Mr. Simmons were recognized and awarded as the best faculty/student research team for the entire College of Science and Mathematics at CSUSM (2013). Currently, Mr. Simmons is pursuing graduate school at U.C. Boulder. His first year project is in the field of experimental plasma physics. Another undergraduate student, Mr. Hector Ceja, presented a poster on the plasma globe at the 2014 APS-DPP meeting [5]. (This was technically outside the grant period but travel funds were piecemealed together internally). Other outreach efforts included extensive discussions and intriguing demos at the ‘plasma chamber’ tent at *Super Stem Saturday*, an annual event held at CSUSM featuring thousands of students and parents (over 5k in 2014) who come to the campus to learn about regional research with hands-on activities and interactive exhibits.

Altogether the PI is grateful for the 3-year funding period that is now completed and hopeful that future work on this exciting project will merit further funding.

[1] M.D. Campanell, J.N. Larid, T. Provost, S.W. Vasquez, S.J. Zweben, "*Measurements of the motion of filaments in a plasma ball*", Phys. Plasmas **17**, 053507 (2010)

[2] M.J. Burin, G. G. Simmons*, H. G. Ceja*, A. Nagy, and S.J. Zweben, "*Experiments on filament structure in a commercial plasma globe*" submitted to Phys. Plasmas Nov. 2014 (review pending)

[3] M.J. Burin, L. Saucedo*, D.R. Wilson*, S.J. Zweben, A. Zwicker, C. Brunkhorst, "*Sensitivity of RF-driven plasma filaments to trace gases in neon*" (TP8.00116), Bull. Am. Phys. Soc. 2012;
M.J. Burin, G.G. Simmons*, L. Saucedo*, A. Nagy, S.J. Zweben, "*Filamentary Discharges: on the Physics of Plasma Globes*" (UP8.00126), Bull. Am. Phys. Soc. 2013

[4] G.G. Simmons*, L. Saucedo* M.J. Burin, A. Nagy, S.J. Zweben, "*Voltage Effects on a Commercial Plasma Globe*" (JP8.00028), Bull. Am. Phys. Soc. 2013

[5] H. G. Ceja*, M.J. Burin, G. G. Simmons*, A. Nagy, and S.J. Zweben, "*Plasma Globe Filamentary Structure and Propagation Trends by Voltage Waveform Change*" (JP8.00025), Bull. Am. Phys. Soc. 2014

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