

*Michigan Institute for Plasma Science and Engineering (MIPSE)*

**Jun-Chieh (Jerry) Wang**

Advisor: **Prof. Mark J. Kushner**  
Electrical Engineering and Computer Science

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**Project Description**

Arrays of micro-plasmas having dimensions of tens to hundreds of microns are finding use as sources of radicals and charged particles. In one version, the electrodes are fully or partially covered by dielectrics, and operate at atmospheric pressure driven with radio frequency (rf) wave forms. So these devices operate as dielectric barrier discharges (micro-DBDs). After the plasma is generated charging of the dielectric terminates the discharge. In certain applications, it may be desirable to extract electron current out of the mDBD plasma, which necessitates a third electrode. In this project, we will discuss the properties of mDBD's sustained in atmospheric pressure  $N_2$  and air using results from a two-dimensional plasma simulation, nonPDPSIM. The micro-DBD's are sandwich structures with an opening of ten-of-microns excited with rf voltage waveforms and an extraction electrode up to 0.5 mm away. We find that following avalanche by electron impact ionization in the mDBD cavity, the plasma can be expelled from the mDBD cavity towards the collection electrode during the part of the rf cycle when the collection electrode appears anodic. This extraction can be enhanced by biasing the extraction electrode. At lower frequencies, the plasma needs to be reformed every cycle. Long lived neutral species facilitate the plasma reforming by production of UV photons that continuously seed secondary electrons at surfaces. The amount of extracted charge per pulse is not a strong function of rf frequency for values up to 25 MHz, but is sensitive to the dielectric constant of the barrier. For applied voltages of up to 2-3 kV, electric field emission appears not to play an important role.

**Wang, Jun-Chieh "Jerry"**

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**OBJECTIVE:**

Graduate student position in **Department of Electrical Engineering and Computer Science, University of Michigan**, where a solid background in plasma physics and research experience would be needed.

**SUMMARY:**

Highly motivated and enthusiastic young scientist with several years of teaching assistant experience and nearly five years of research experience in plasma-related fields. Excellent programming skills with FORTRAN and MATLAB language, and especially skilled at working under Linux.

**NOTABLE ACCOMPLISHMENTS:**

- Worked with *Hewlett Packard Research Labs* for mDBD's micro-plasma simulation.
- Worked with my advisor in proposing a single mechanism, Microwave Plasma Confinement (MWPC), to achieve plasma confinement and ion heating. The result was presented orally at the "**49th Annual Meeting of the Division of Plasma Physics**" in Florida, 2007.
- Worked with my advisor and colleagues to demonstrate that the relativistic effect in electromagnetic (EM) cyclotron instability is more important than the classical mechanism. The results of this work were published in **PRE** (Phys. Rev. E 71, 036410, 2005).
- In the "NSC (National Science Council) undergraduate student research project", I worked with my advisor to derive a rudimentary theory of fractional harmonic resonance.
- Individually developed scripts for image processing and data visualization on a Linux platform.

**WORK EXPERIENCE:**

2009/9 ~

**PhD (GSRA)**, Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor

- Micro-Dielectric Barrier Discharge (mDBD's) simulation.

2008/12 ~ 2009/7

**Research Assistant**, Plasma and Space Science Center, NCKU

- Propose a possible mechanism to explain the Pre-earthquake phenomena.

2006/12 ~ 2007/12

**Research Assistant**, Department of Physics in NCKU

- Derived a simple model of the dispersion relation of waves in uniform plasma with consideration of the thermal effect.

- Derived a simplified theoretical model of Microwave Plasma Confinement (MWPC) which achieves plasma confinement and ion heating in a single mechanism.
- Developed a code for solving a variable coefficient 2<sup>nd</sup> order wave equation which describes the wave and its instability behavior.

2005/8 ~ 2006/11

**Served in the Taiwanese Army**

- Manager in the Documentation and Archives Office.
- Provided the officers with official editing support and proofreading.

2004/7 ~ 2005/7

**Teaching Assistant**, Department of Physics in NCKU

- Performed physics experiments and gave lectures on the concepts behind them.
- Assisted in grading tests.

2003/7 ~ 2004/7

**Teaching Assistant**, Department of Physics in NCKU

- Prepared course handouts for the Introduction to Plasma Physics class.
- Helped students to improve their understanding of plasma by providing extra materials.
- Assisted in grading tests, term papers and term projects.

2004/9 ~

**Editor**, Sciscape.org

- Offered reports on the latest research and science news in Chinese to the public.

**EDUCATION:**

**PhD, EECS Department, 2009 ~ present**

University of Michigan, Ann Arbor, MI

**Supervisor:** Prof. Mark. J. Kushner    Email: [mjkush@umich.edu](mailto:mjkush@umich.edu)

**M.S., Department of Physics, 2005**

National Cheng Kung University (NCKU), Tainan, Taiwan.

**B.S., Department of Physics, 2003**

National Cheng Kung University (NCKU), Tainan, Taiwan.

**PROGRAMMING SKILLS:**

FORTRAN, MATLAB, Linux script.

**AWARDS AND SCHOLARSHIPS:**

President's Award, 2002 (Ranking **2nd**)

President's Award, 2001 (Ranking **3rd**)

President's Award, 2000 (Ranking **3rd**)

**PUBLICATIONS:**

- J. Y. Hsu and J. C. Wang, "**Microwave Plasma Confinement and Ion Heating**", oral presentation at "49th Annual Meeting of the Division of Plasma Physics" in Florida, USA, 2007.
- K. R. Chen, J. D. Huang, J. C. Wang, and Y. Y. Chen, "**Relativistic electromagnetic ion cyclotron instabilities**", Phys. Rev. E. 71, p.036410 (2005).

**Conference Proceedings and Presentations:**

- Jun-Chieh Wang, Napoleon Leoni, Omer Gila and Mark J. Kushner, "**RF Excited Micro-Dielectric Barrier Discharges With Electron Current Extraction**", Annual Meeting of DOE Plasma Science Center, Michigan, USA, 2010.
- J. Y. Hsu and J. C. Wang, "**Microwave Plasma Confinement and Ion Heating**", oral presentation at "49th Annual Meeting of the Division of Plasma Physics", Florida, USA, 2007.
- J.C. Wang, R.D. Huang, Y.Y. Chen and K.R. Chen, "**Relativistic electromagnetic ion cyclotron instabilities**", PSROC, Taiwan, 2004