PlasMachine Project update 1: July 1, 2013

Project Developments

At this stage, our project developments have focused on lab-scale research. We are continuing the important step of translating our plasma technology from expensive, commercial lab equipment to cheap, robust devices suitable for “field” deployment in the developing world or other low-resources situations. Currently, we have identified three promising device configurations for plasma production: a flat planar electrode that could be place on top of a box for instrument or surface disinfection (see Figure 1), a hollow tube with convective airflow for ozonization and disinfection of water (see Figure 2), and an “electrospray” source for smaller-scale disinfection of either surfaces or liquid volumes (see Figure 3).

A particular challenge is characterizing the relationship between device design and configuration, plasma chemistry, and disinfection efficacy. Here, we have most thoroughly studied the tube ozonizer device. This device uses an AC or DC neon sign transformer as a power source (costing about $50), and a ceramic tube/threaded rod assembly as a plasma source (costing less than $20). Important operational parameters in its operation include air flow (or residence time inside the reactor) and power input to the discharge; design parameters including device geometry also affect chemistry and disinfection capability. Our most important conclusion with regard to ozone production so far is that production increases with energy per volume, or input power divided by flow rate. Figure 4 shows a preliminary scaling relationship.

Lessons Learned

Ozone production increases up to a maximum as energy/volume increases, implying that plasma disinfection becomes more effective with increasing energy input, but only within a certain energy range. This result is especially important as we seek to develop a device suitable for low-resource settings because it gives a crucial design constraint: if we operate a device with less power, its potential for disinfection is reduced, but if we operate at higher power, we waste valuable energy without benefitting from more powerful disinfection.

Next Steps

PlasMachine remains on track to reach its goal of designing a variety of prototype devices and characterizing their plasma chemistry by the end of August 2013. In the coming weeks, we aim to better characterize the power efficiency of the ozonizer device and understand the gas- and aqueous-phase chemistry created by the other plasma sources we have developed. Then, we will characterize our devices’ antibacterial effect on a variety of contaminated media. Finally, we will develop a “second-generation” prototype from our most promising configuration with the aim of conducting field tests by summer 2014.

Updates on Funding and Support

The PlasMachine team continues to grow. New laboratory researchers include Toshisato Ono and Hayato Obo, electrical engineers from Tokyo Tech, who are helping us to understand the electrical characteristics of our devices and will eventually develop a custom power supply optimized for our device; and Alexander Lill, a biochemist from UC Santa Cruz, assisting with antibacterial and biochemical assays.

Connor is spending the summer in Nicaragua with the Cal Energy Corps and is exploring the possibility of collaborations in Nicaragua to bring a prototype plasma device there. He blogs at http://vcresearch.berkeley.edu/energy/cal-energy-corps-summer-2013-participants-work-connor-galleher to describe his summer project.

Ideas for Further Support

As PlasMachine narrows down its device design to an optimized, field-ready prototype, it would be useful to connect with potential end users of our technology. What is a realistic cost that a user might be willing to pay for a PlasMachine device? What sort of operating constraints (size, power usage, geometry, etc.) would exist in the field? How long is an acceptable treatment duration? By contacting clinicians or technicians in the developing world or elsewhere, we could get a better idea of what constraints exist on our design, and we could produce a product more likely to be accepted and used practically. Any connections or contacts we could get in touch with would be helpful going forward.

About PlasMachine

PlasMachine's co-founders are Connor Galleher (connorgalleher@berkeley.edu) and Matt Pavlovich (mattpavlovich@berkeley.edu). Visit us at http://graves-lab.cchem.berkeley.edu/agp/.

Images and Figures

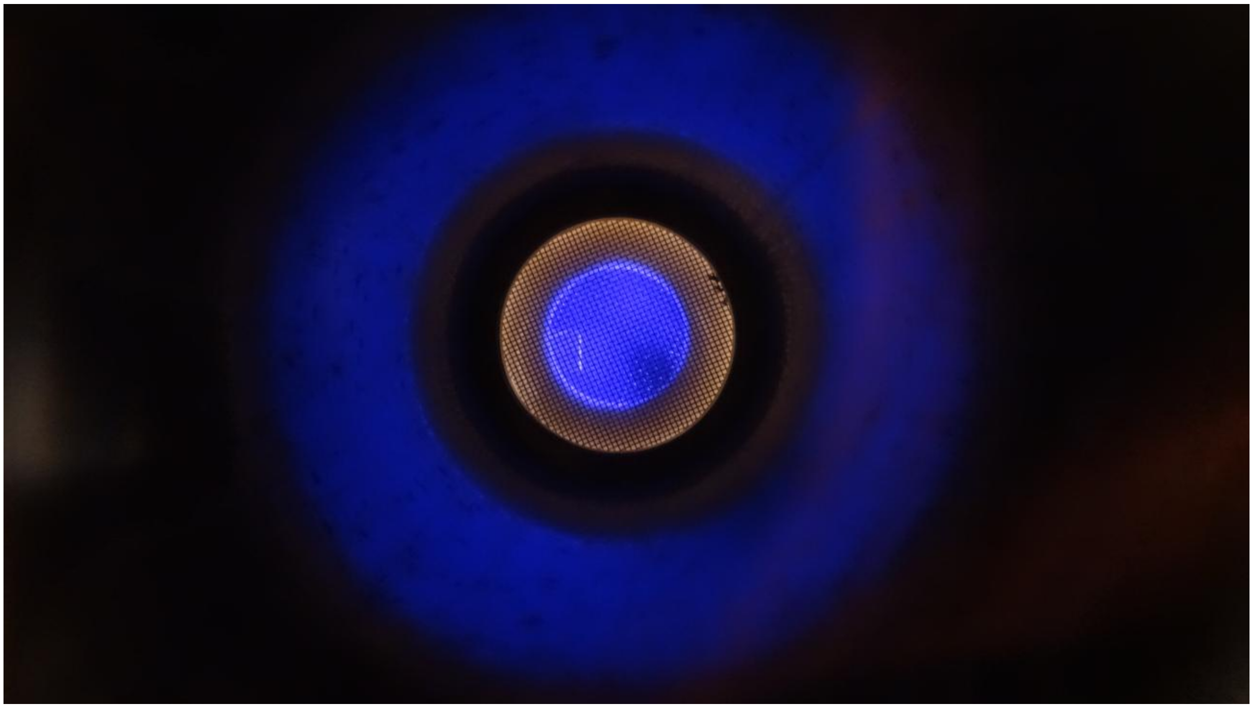

Figure 1, a flat planar electrode setup ideal for disinfecting surfaces or instruments.

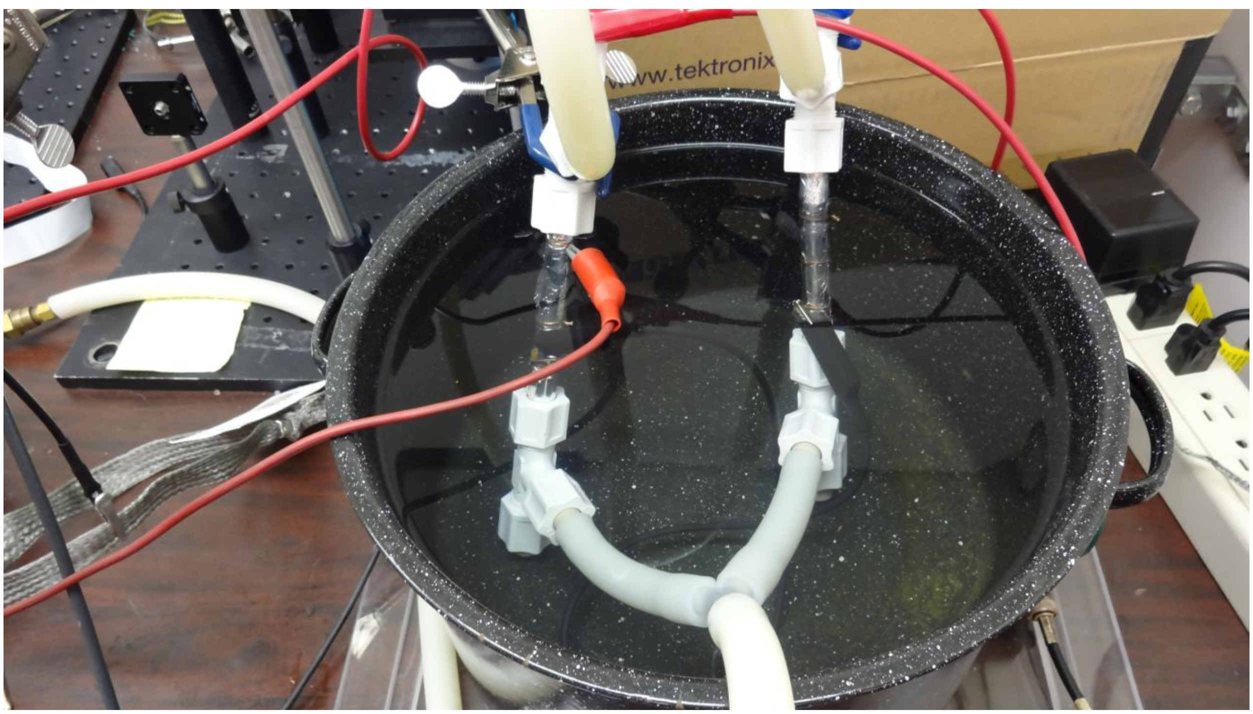

Figure 2, tubular plasma reactors designed to produce ozone for water disinfection.

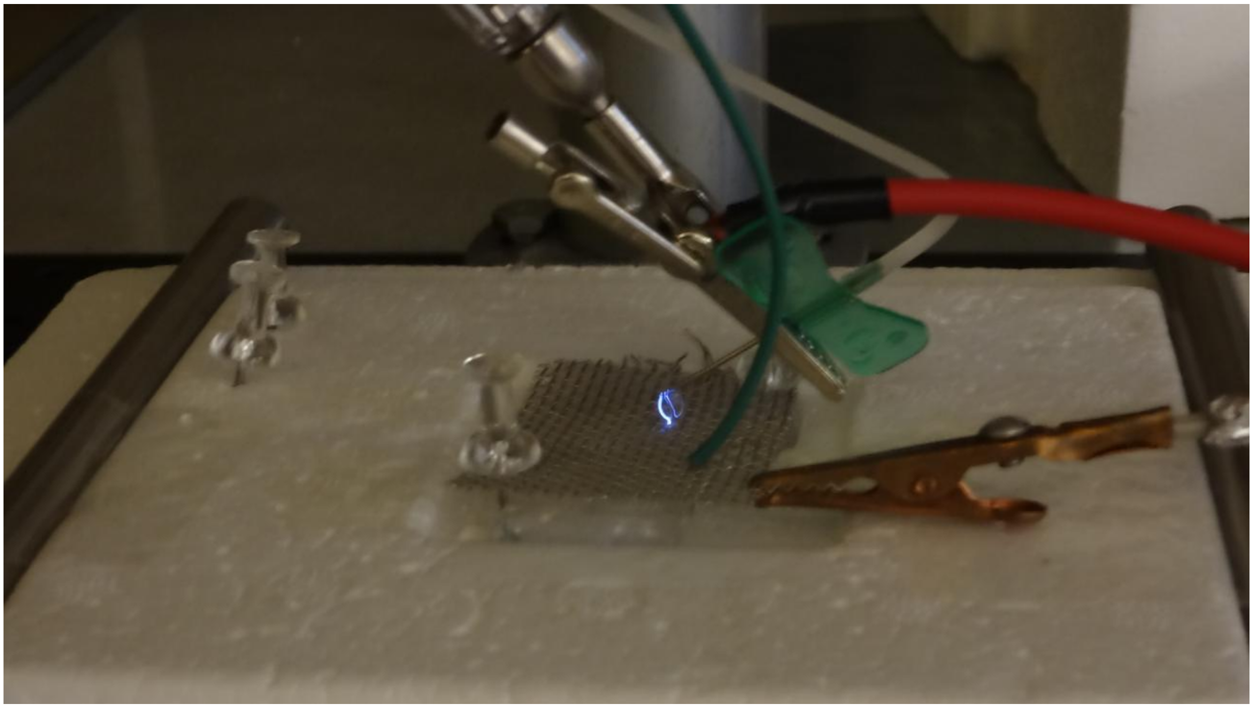

Figure 3, a spark/electrospray configuration best suited for smaller-scale disinfection.

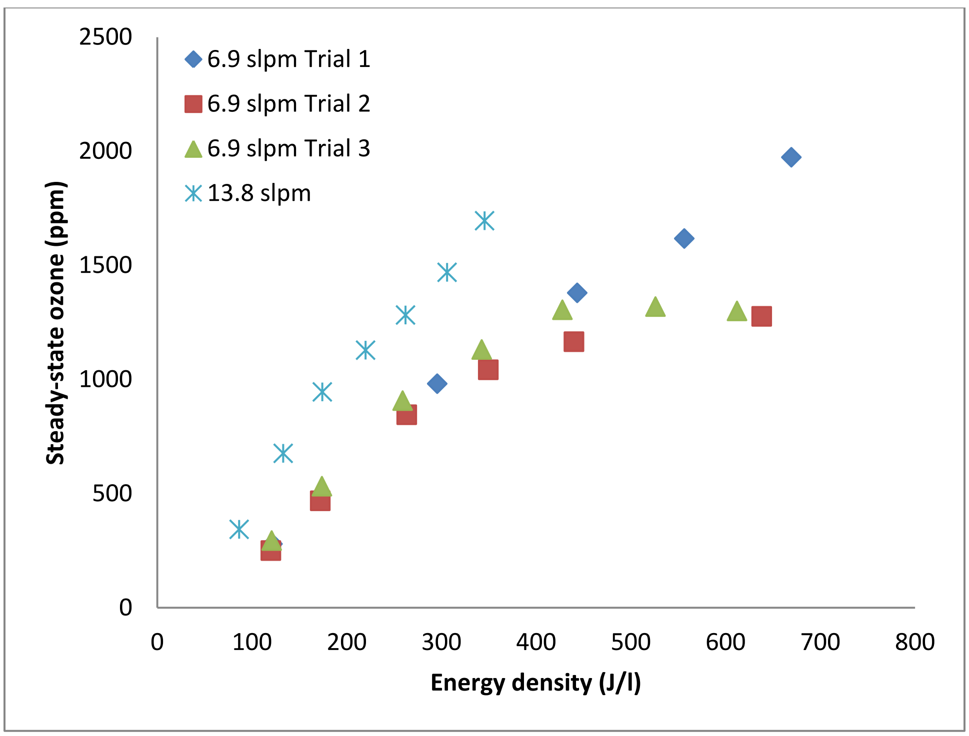

Figure 4, preliminary gas-phase ozone concentration data for our ozonizer under a variety of operating conditions. Within some range, ozone scales well with energy per volume of ozonized air.