# Modeling Sheath Dynamics around Water Droplets in Low Temperature Plasmas*

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Low temperature, atmospheric pressure plasmas and their interactions with liquids are important in many applications, including plasma medicine and water treatment. These applications rely on chemically reactive species transporting to the liquid to chemically activate the liquid. Chemical activation is limited by transport since the reactive species must first be produced in the plasma, transport to the surface of the liquid, and diffuse into the bulk liquid. A high surface to volume ratio of the liquid enables rapid activation, as well as a short distance between the location where the reactive species are produced and the liquid. The interface between the plasma and liquid is very complex, due to short-lived species interactions, evaporation of the liquid, charging of the liquid, and sheath dynamics.

The dynamics of the sheath around a water droplet with a high surface to volume ratio immersed in a helium plasma are investigated using the 2D modeling platform *nonPDPSIM*. The helium plasma is formed in a radio frequency (RF) glow discharge at atmospheric pressure, based on the reactor used in Oinuma et al. [1] The RF sinusoidal voltage is assumed to oscillate at 10 MHz. To investigate the dynamics of the sheath, the water droplet is modeled as a dielectric droplet with a relative permittivity of 80, and the liquid phase chemistry is not tracked.

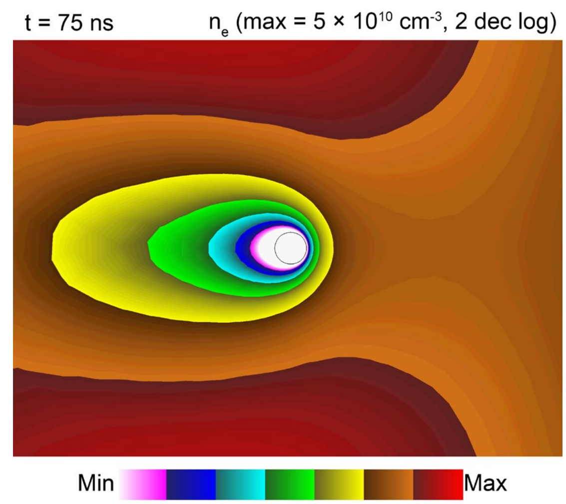


Figure 1 – Electron density at 75 ns from the start of the 40th RF cycle. The dielectric droplet is 40 microns in diameter and nonconductive, with an RF voltage amplitude of 200 V.

The sheath is shown to oscillate asymmetrically throughout the RF cycle. A snapshot of the electron density at 75 ns from the start of the $40^{th}$ RF cycle is shown in Fig. 1. Other important properties like polarization, electric field, and electron temperature show oscillations throughout the RF cycle. Changing the RF voltage amplitude, conductivity, and diameter of the droplet show differences in the sheath surrounding the droplet.

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**References**

[1] G. Oinuma et al, Plasma Sources Sci. Technol. **29**, 095002 (2020).