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Mapping of 2-D plasma-induced fluid flow using particle image velocimetry

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Plasmas coming into contact with liquid water is the basis of a range of technological applications for environmental remediation and medicine. These technologies are enabled by complex plasma-driven chemical and physical processes at the plasma-liquid interface. At the interface, however, plasmas can also drive Marangoni flow in the bulk liquid. This effect can thus circulate reactive species in the bulk liquid, to regions far away from the plasma-liquid interface. Mapping this plasma-driven fluid flow gives insight into how plasma locally alters the contact area chemically and physically. Accounting for plasma-driven flow can ultimately impact the design and application of technologies using plasmas.

A 2-D plasma-in-liquid apparatus was used to study the plasma-liquid interfacial region. The observed plasma-driven flow was mapped using particle image velocimetry (PIV). Previous PIV results showed that sharp velocity shear was present near the interface region, which led to the presence of stable Kelvin-Helmholtz perturbation. Additionally, sharp sheer created vortices in the bulk liquid, resulting in large-scale circulation that transported plasma-derived reactive species far away from the interface.

In this work, we present results of a fully calibrated, mapped plasma-induced fluid flow field in the presence of varying liquid conditions. Because conductivity and surface tension impact how streamers propagate along the interface, and as a result alter the induced chemistry, it is also of interest to observe how fluid flow changes as well in response. Furthering the understanding of transport processes at the interface thus becomes relevant for plasma applications seeking to process any liquid or liquid containing media.

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