Online LTP Seminar
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Multiscale Modeling of Plasma Water Interfaces

Davide Curreli

University of Illinois Urbana-Champaign

Plasma-liquid systems are experiencing growing interest in plasma science and technology. In particular, interaction of plasmas with liquid water are of utmost importance, due to their relevance in plasma medicine, chemical processing, and for the production of reactive oxygen and nitrogen species. In this online seminar we will summarize recent modeling activities of humid air and humid argon DC plasmas interfaced with a liquid water surface, performed using the newly developed open-source software Zapdos-Crane, built using the Moose finite-element framework. We will provide a brief overview of the software, highlighting its availability to the LTP community, and showing two study cases of plasma-liquid interfaces.

In the argon-water problem, electrons from the plasma are allowed to directly penetrate the water interface through advection, and heavy species transport between gas and liquid phases is included through a local Henry's law. The results suggest that increasing electron current density increases solvated electron concentration at the interface but decreases penetration depth, a result corroborated by previous works. The role of solvated electrons at the interface on limiting the permeability of radicals across the interface is also numerically analyzed.

In the air-water problem, the chemical pathways leading to the production of reactive oxygen and nitrogen species in both the gas and liquid phases are analyzed. From our numerical tests, we observe that aqueous species accumulation is largely controlled by the thin layer of solvated electrons forming at the plasma-water interface. Preliminary comparisons of selected radicals against experiments in a plasma electrolytic cell are also shown.

Short Bio

Davide Curreli is Associate Professor in the Department of Nuclear, Plasma, and Radiological Engineering at the University of Illinois Urbana-Champaign, and at the National Center for Supercomputing Applications. Dr Curreli leads the Laboratory of Computational Plasma Physics at Illinois. His research activities focus on computational modeling of plasma material interactions and plasma chemistry of low-temperature plasmas for fusion and nuclear applications. Among his current research activities, Dr Curreli is coordinator of the Nuclear Fireball Plasma Chemistry activities within the University Research Alliance funded by DOD DTRA. His group actively works on multiple projects in Fusion Energy Sciences. Dr Curreli is Donald Biggar Willett Faculty Scholar at the University of Illinois.