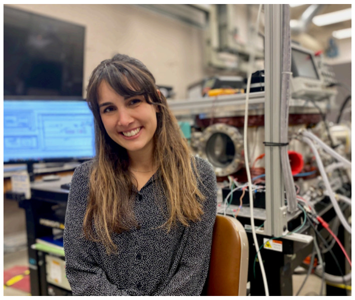
UCLA

Plasma Physics Seminar

Physics & Astronomy Building (PAB) Room 4-330
Via Zoom: https://ucla.zoom.us/j/92785449357?pwd=SVBTSko3bTdEUW03dzQwNks1Q2lKZz09
Friday, May 12, 2023
11:30 AM Lunch will be served

Plasma Interactions and Electron Dynamics for Volumetrically Complex Materials

Angelica Ottaviano (UCLA)



To advance the lifetime and performance of most plasma devices it is crucial to consider the mechanisms and interactions occurring at the physical material boundary between a plasma and the plasma itself. This field is often referred to as plasma-material interactions (PMI), and has far-reaching applications from magnetic conferment fusion, high-thrust density space propulsion technologies, particle accelerator physics, to radiofrequency components development. In recent years, volumetrically complex materials (VCMs) have shown to be promising candidates for plasma-facing components due to geometric trapping of emitted particles such as from secondary electron emission (SEE) and sputtering. In addition, the possibility of driving liquid flow through porous structures make VCMs such as foams attractive candidates for a range of plasmas applications. This work aims to investigate the key PMI of VCMs with focus on SEE and ion-induced sputtering by using a combination of experimental and analytical methods.

An experimental technique which simultaneously evaluates the SEE from a surface and its morphology via scanning electron microscopy (SEM) [1] was used to study SEE trends for reticulated carbon foams [2], and direct SEE measurement and spectroscopy setups at the Princeton Plasma Physics Laboratory were used to further investigate suppression and generation of secondary electrons. To investigate inter-foam deposition and sputterant transport within pore layers, a dedicated hollow-cathode generated plasma device was developed at UCLA. A collaboration project with BaPSF was also carried out to study the effect of biased tungsten foams in a pulsed He plasma on material erosion and arcing in comparison with a planar surface [3].

SEE investigations revealed up to 43% suppression from foam compared with a flat surface and the presence of an optimal geometric configuration, which is in good agreement with current and past analytical and computational models [4]. Foams are also shown to exhibit multi-scale behavior: micron featured foams indicate a loss of angular dependence much like fuzzes, while mm-scale foams are directional like fibrous surfaces. Electron spectroscopy revealed that backscattered electron suppression is >80% more than low energy SEE suppression in carbon foams, while low energy secondary electron generation may be enhanced. Sputtering experiments have shown that plasma-infusion is key in determining inter-foam transport for predicting back vs forward material sputtering, and that tungsten micro-foams can withstand up to 600 V negative bias in a continuous or pulsed plasma environment, with significant reduction of arcing events when comparing to planar tungsten.