Status of the UCSD POSEIDON facility: An experiment for the study of simulated burning plasma-material interactions

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Energy-producing D-T fusion reactors require plasma-facing materials (PFMs) capable of withstanding extreme plasma heat and particle loads, and also the damaging effects of neutrons. In laboratory experiments on plasma-material interactions, a target material is typically exposed to a dense plasma that simulates a fusion typical particle and heat flux. Likewise, in fusion material damage studies, at least some of the effects of neutrons in a material target surface region are investigated with the use of high-energy accelerated ions that lead to displacement damage in the cascades caused by knock-on atoms. Combining these two types of experiments to study materials response in a state more relevant to a burning plasma typically involves a stepwise procedure [1]. For instance, a damage step is followed by a plasma exposure step. Unfortunately, this approach reduces the potential for examining the more realistic and synergistic material response, where both the plasma exposure and displacement damage occur together.

The Plasma On Simultaneous Energetic Incident Damage by iONs (POSEIDON) experiment at UCSD is a new facility for exploring the synergistic response of PFMs undergoing simultaneous high-flux plasma exposure and displacement damage in the near surface of PFMs. This new experiment couples the PISCES-RF linear plasma device with a helicon plasma source [2] and a 3 MV Pelletron accelerator system (National Electrostatics Corporation) so as to focus, simultaneously, a high-flux plasma and high-energy damaging ions onto a PFM target. This allows material performance to be explained in an environment that emulates the effects of material aging in a burning fusion reactor.

The presentation will provide an update on the operational status of POSEIDON, describe the parameter space, outline details on the onboard plasma and material diagnostics, and present the first results of synergistic materials response in a PFM target undergoing simultaneous plasma exposure and displacement damage.

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[1] T Schwarz-Selinger, Mater. Res. Express 10, 102002 (2023)
[2] M.J. Baldwin, D. Nishijima, M.I. Patino et al., Nucl. Mater. Energy 36, 101477 (2023)

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