Dry Chamber Wall Thermo-Mechanical Behavior and Lifetime under IFE Cyclic Energy Deposition

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Lifetime is a key issue for the IFE dry chamber wall configuration. Past studies, such as SOMBRERO, indicated the need for a protective gas to prevent unacceptable wall erosion for a carbon chamber wall even for direct-drive targets. A recent effort as part of the ARIES-IFE program has provided a more detailed assessment of dry chamber wall based on ion and photon spectra from a new direct-drive target proposed by NRL and an updated indirect-drive target from LLNL. Several material options were considered including carbon and tungsten flat wall and a high-porosity fibrous carbon configuration to maximize the incident surface area and help accommodate the energy deposition. Detailed analyses using very fine meshes were performed for both the energy deposition from the photons and ions and the thermal behavior of the wall which included melting (in the case of tungsten) and sublimation. The time of flight effect for both the photons and ions were included, whereby the photon energy reaches the wall faster than the ion energy, and a dramatic effect on the wall thermal and erosion behavior was observed when compared to the previously-assumed instantaneous energy deposition case. Results for both direct-drive and indirect-drive targets will be presented. For the direct-drive spectra, a design window seems to exist even for a case without a protective gas which will greatly simplify the requirements for target injection. The presence of a protective gas such as xenon is much more important for the indirect-drive spectra. The implication of the results on IFE chamber and reactor design will be discussed and some of the key issues summarized, including the effect of potentially important erosion processes such as radiation enhanced sublimation and macroscopic erosion for carbon and the applicability of existing equilibrium-based property data to the highly cyclic IFE case.

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