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DESIGN AND NUMERICAL STRESS ANALYSIS OF SILICON MEMBRANE HIBACHI WINDOWS*

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A silicon membrane hibachi window was designed and manufactured for the High Average Power Laser (HAPL) Inertial Fusion Energy (IFE) program. The window has to allow electron beams to go through with at least 80 percent efficiency while maintaining full structural integrity during a pulsed pressure load of 2.5 atm (0.25 MPA). The windows is round in shape with a 50mm diameter and 150 micron thickness. To meet the requirement, various materials were examined and silicon was chosen due to its high electron penetration rate, thermal stability (Thermal Expansion Rate of Silicon: 2.7 ppm/K at 100 C and 4.7 ppm/K at 700 C), and robust structural stability.

The most important and conflicting design parameter for the window is the thickness. A mechanically thick window while solid and safe, will result in poor electron beam penetration, which hampers the interaction with the KrF gas in the laser chamber. If too thin, the window can not endure mechanical stresses by the pressure and thermal loads with dynamic electron pulsing. The designed silicon foil exhibits very solid mechanical behavior and passed various experiments of electron beam shots with pressure and thermal loads. The window design is focused on providing more than 100,000 electron beam shots with 5 hertz pulsed 2.3 atm overpressure and a thermal load of 300 C.

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