

Silicon/Nanocrystalline Diamond Hibachi Window

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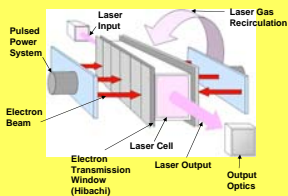
Abstract

In support of Inertial Fusion Energy (IFE) a 150 μm thick silicon (Si) foil coated on one side with a 1.2 μm thick nanocrystalline diamond has been fabricated as an electron beam transmission (hibachi) window for employment in a repetitively pulsed e-beam pumped laser. The hibachi window separates the lasing medium from the electron beam source while allowing the electron beam to pass through. The hibachi window must be capable of withstanding the challenging environment presented in the lasing chamber, which may include; fluorine gas, dynamic delta pressures > 2 atm @ 5 Hz, and a high heat flux due to the transmission of electrons passing through the foil. Tests at NRL/Electra and at PPPL have shown that a device employing these novel components in the stated configuration provide for a robust hibachi window with structural integrity.

The current development in this task is for the fabrication of a multi-window prototype module.

This work is supported by the Naval Research Laboratory (NRL) in collaboration with the Princeton Plasma Physics Laboratory (PPPL).

Theory

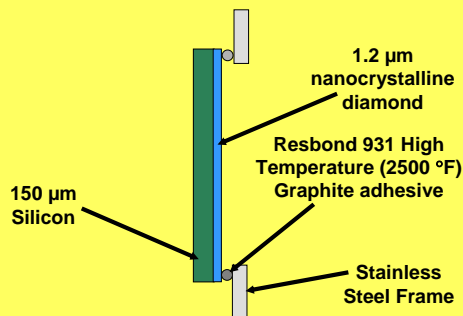


Properties	Silicon (SCS)	Nanocrystalline Diamond
Yield Strength:	7000 MPa	53000 MPa
Young's Modulus:	190 GPa	7000 GPa
Thermal Conductivity:	157 w/m °C	2,000 w/m °C
Thermal Expansion:	2.33 E-06 / °C	1.0 E-06 / °C

The electron beam transmission window must allow > 80% beam energy transmission while withstanding a harsh environment that can include: fluorine gas, 5 Hz cyclic pressure ($\Delta P_{\text{ABS}} \approx 2.0$ to 2.5 atm), and thermal load.



Silicon/Diamond Foil Configuration



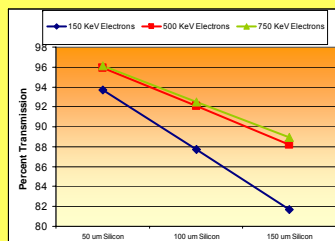
This foil configuration successfully tested at Electra in single, burst, and multi Hz rep rates.

Window Transmission Efficiency (In Vacuum)

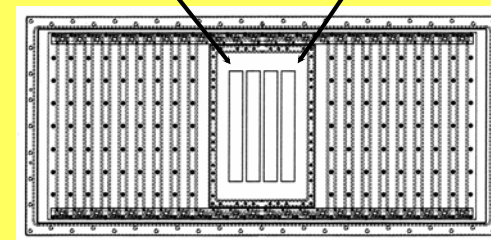
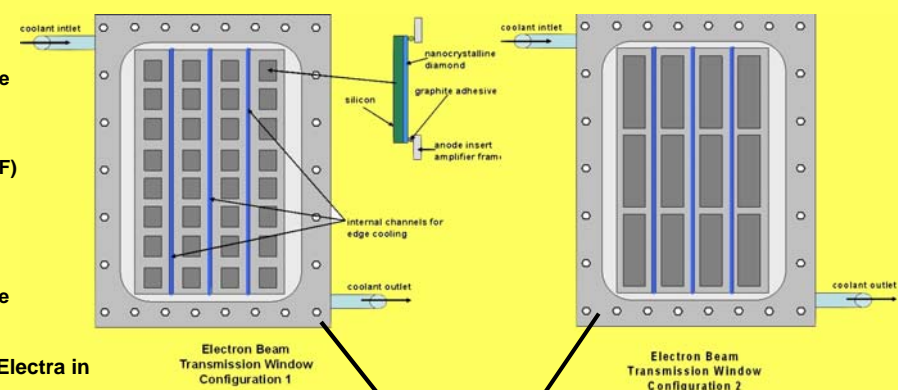
Si with 2 μm diamond passivation layer

750 KeV 500 KeV 150 KeV

50 μm	96.1	95.9	93.7
100 μm	92.5	92.1	87.7
150 μm	88.9	88.2	81.7



Multi-Window Hibachi Cooled Anode Insert



Anode Plate Electra Amplifier

Summary

A viable Si/nanocrystalline diamond electron beam (hibachi) transmission window has been successfully tested at Electra.

Currently the window is undergoing extended cycle bench testing at PPPL.

The development of a prototype multi-window hibachi test module with edge cooling is being fabricated for testing at Electra.

