NTech Lehrstuhl für Nukleartechnik

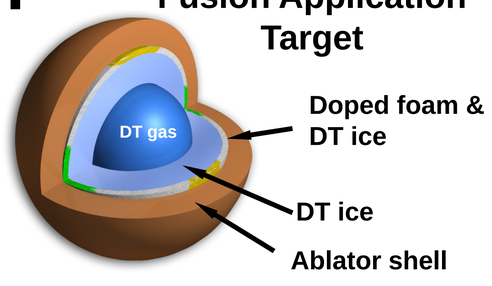
Lawrence Livermore National Laboratory

Targets for Inertial Confinement Fusion: Novel Materials from Synthesis to Application

C. Dawedeit, T. Braun, A. Wittstock, S. Kucheyev, J. Biener, J. Satcher, M. Worsley, S. H. Kim, C. Walton, A. Chernov, A. Hamza, T. Willey, T. van Buuren, K. J. Wu,
Collaborators: Fraunhofer-Institut für Angewandte Festkörperphysik, Germany; Diamond Materials, Germany; General Atomics, USA; University of Ulm, Germany;

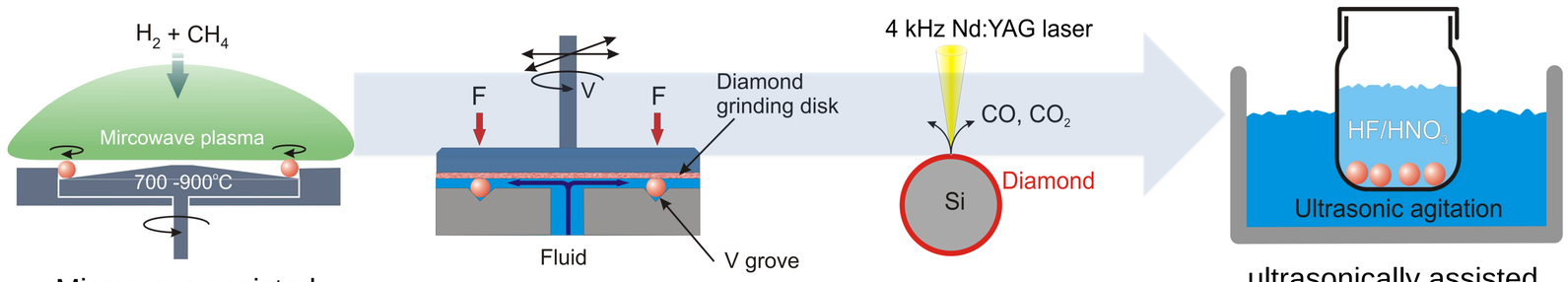
Abstract Complex target structures are necessary for inertial confinement fusion experiments. In order to realize these complex target structures it is necessary to develop new fabrication methods and materials. This poster summarizes our latest developments on Nano-Crystalline Diamond as a target material as well as a low density foam inside a spherical ablator shell for placing dopants in direct contact with the DT-fuel.

Fusion Application Target



Nano-Crystalline Diamond

Fabrication of spherical diamond shells

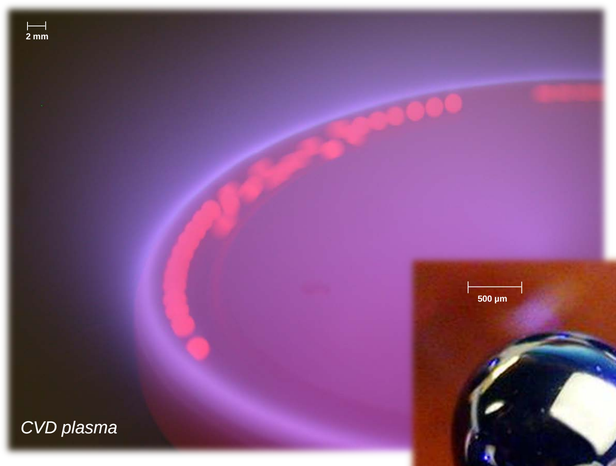


Microwave assisted chemical vapor deposition

Ultra-high precision polishing

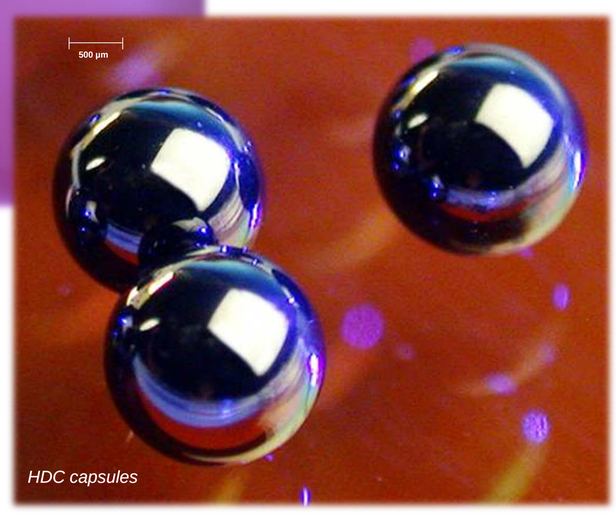
Nd:YAG laser hole drilling

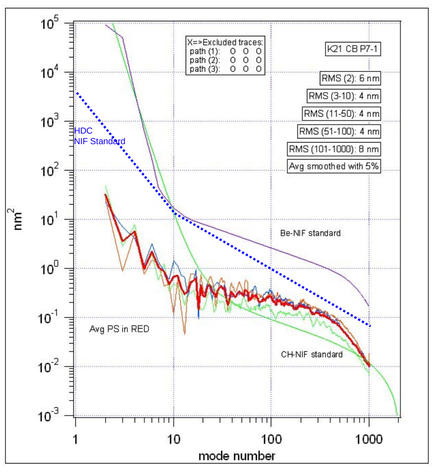
ultrasonically assisted wet etching



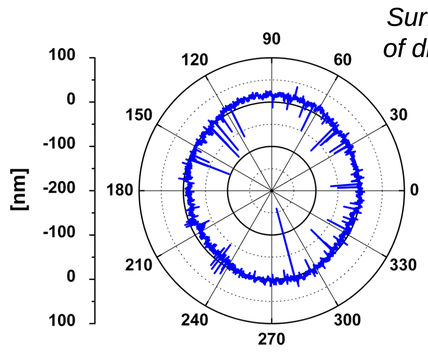
Advantages

- High density leads to efficient energy absorption
- High strength has the potential to reduce instabilities

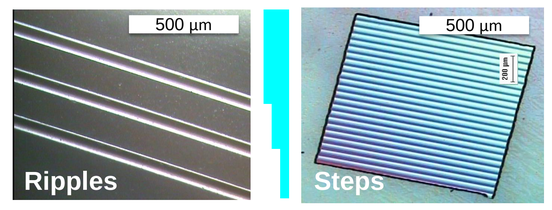




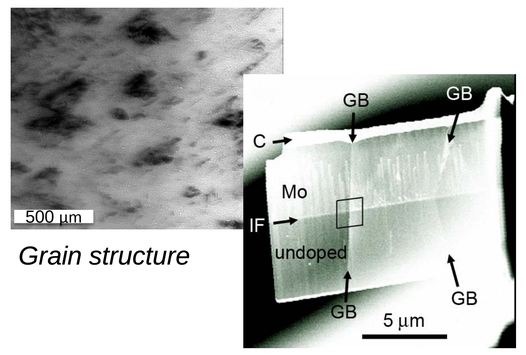
Surface roughness of diamond capsule



HED Targets

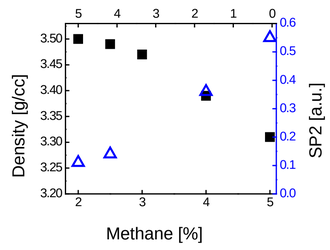


Materials-Engineering



Grain structure

Doping dependency



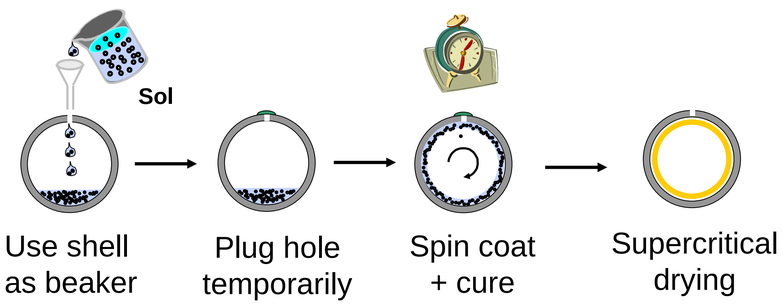
Publications

Biener, M. M et al. *Diam. Relat. Mat.* **19**, p. 643 (2010)
Biener, J. et al. *Nucl. Fusion* **49**,112001 (2009)
Wolfer, M. et al. *Diam. Relat. Mat.* **18**, p. 713 (2009)
Wiora, M. et al. *Diam. Relat. Mat.* **18**, p. 927 (2009)
Bradley, D.K. et al. *Phys. Rev. Lett.* **102**, 075503 (2009)
El-Dasher, B.S. et al. *Appl. Phys. Lett.* **88**, 241915 (2006)
Biener, J. et al. *Fusion Sci. Technol.* **49**, p. 737 (2006)
Kucheyev, S.O. et al. *Appl. Phys. Lett.* **86**, 221914 (2005)

Foam Lined Ablator Shells

New materials and fabrication techniques discovered and developed

Chemistry in a capsule concept



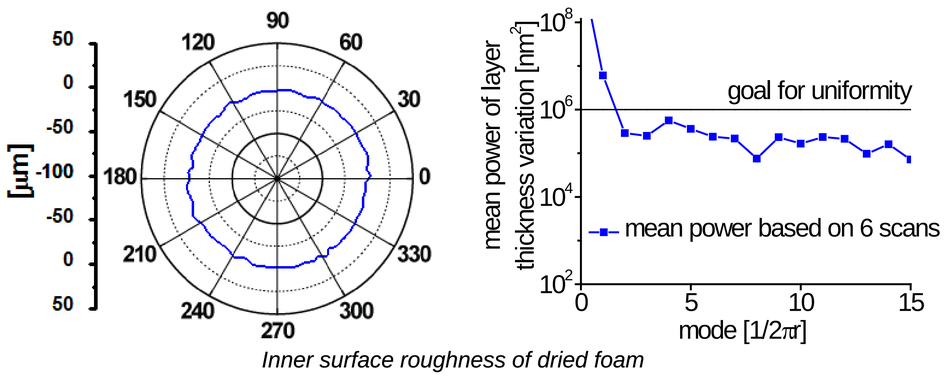
Use shell as beaker

Plug hole temporarily

Spin coat + cure

Supercritical drying

Uniformity of foam thickness

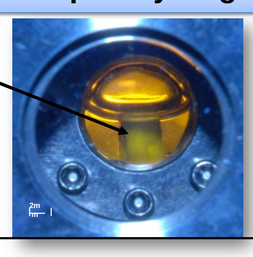


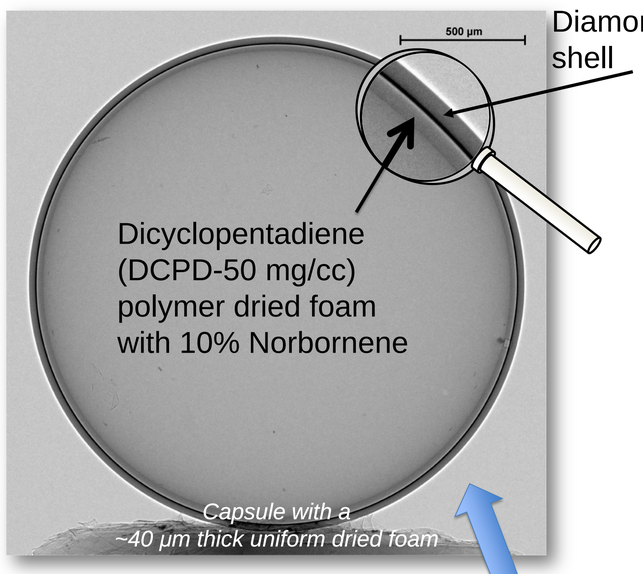
Inner surface roughness of dried foam

Low density foam survives wetting in liquid Hydrogen

good wetting with liquid hydrogen

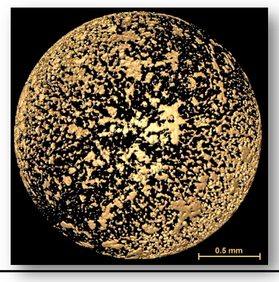
mechanical stability of low density DCPD aerogels during hydrogen wetting is confirmed by small angle x-ray scattering (SAXS)





Challenges

- Thickness uniformity
- Concentricity
- Low densities
- Thin foam shells
- Control rheological properties

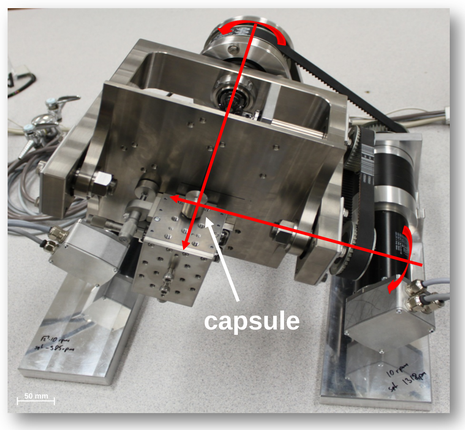


3D Rendering of Foam - Progress Towards Uniform Thin Foam Layer Within Capsule

DCPD (50 mg/cc) with 10% Norbornene

Pure DCPD (50 mg/cc)

Positioning Machine



- provides a deterministic, continuous random change
- two perpendicular and independently driven frames

Publications

Record of Invention accepted: IL-12443

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Security, LLC, Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.