Foams Used in Laser Targets and Possible future targets

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Outline

- Important aspects of foams used as or a components of target for leaser experiments

  - **Chemical composition:** Carbon, Oxygen, what percentage in any given sample; any other elements? What percentage of each present?
    - These all affect the way you make the foam and HOW you make it

  - **Physical properties:** shaping the foam into a shape required by experimenters? Dimensional stability? Etc

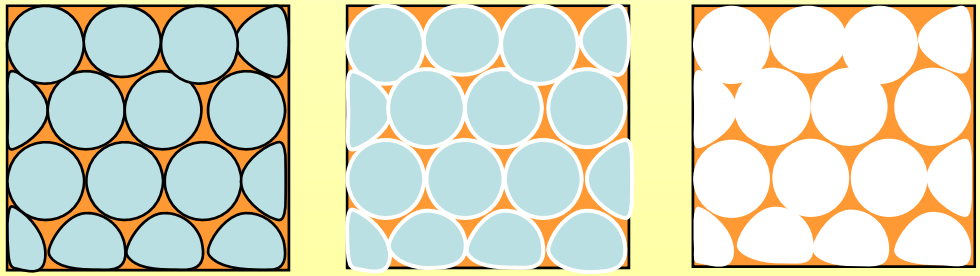
    - Machined: make a large sample then machine to desired shape
    - In-situ: foam fabricated inside the target
    - Moulded: make the foam in a mould and then use

Foams used in Laser targets

- Foams made using Emulsion polymerisation, for example HIPE (High Internal Phase Emulsion)
- Photoinitiated Foams based on Acrylates
- Aerogels
  - Silica aerogels
  - Styrene and Divinyl Benzene organic aerogels.
  - Resorcinol Formaldehyde aerogels as means of producing templated pores using zeolites

HIPE High Internal Phase Emulsions

- HIPE: Emulsions with >70% internal phase
  Water in oil - water acts as porogen



HIPE emulsion

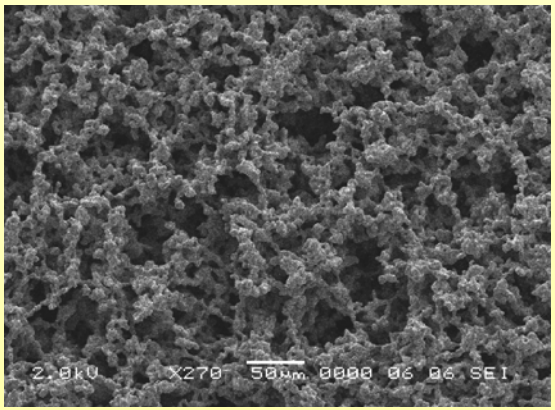
Polymerising HIPE emulsion

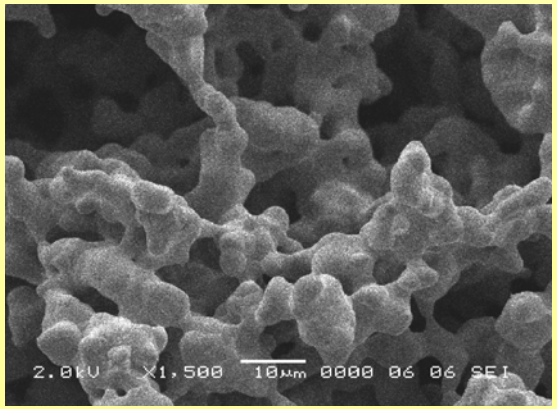
polyHIPE®

Recently, we have found out that the pore sizes can be made smaller by varying some of the parameters.

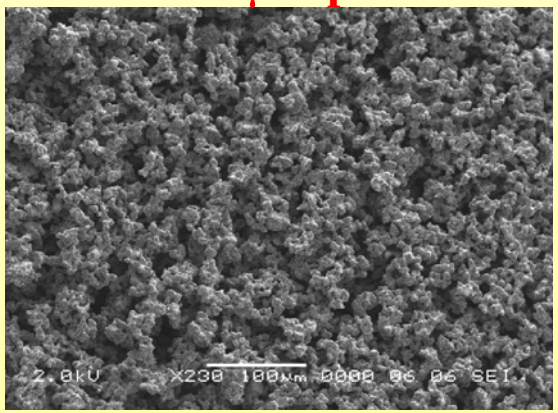
Silver foam made by using HIPE as template

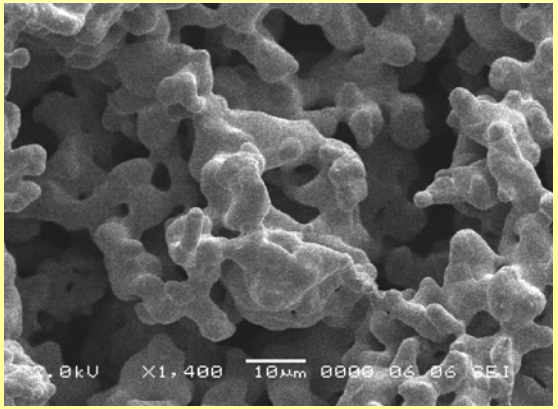
1 μm powder





5 μm powder

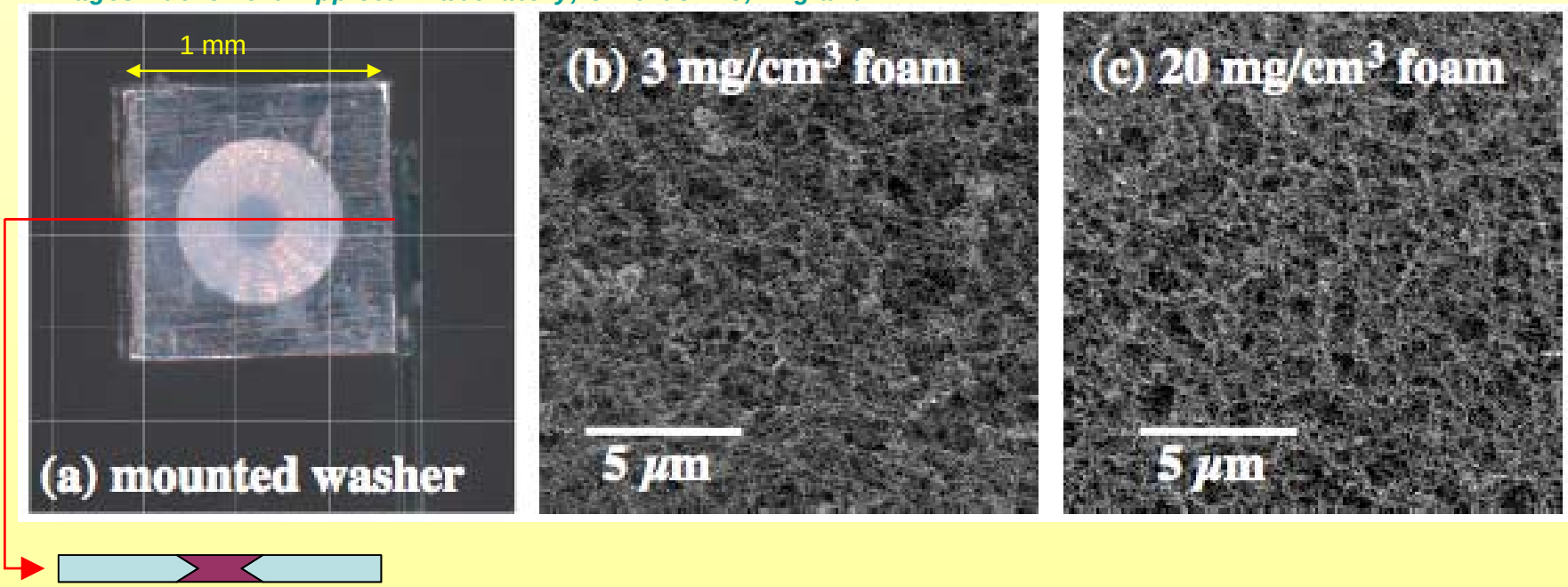




Images: Doug Faith - AWE

Foams-filled targets for Critical density experiment

Images Rutherford Appleton Laboratory, Oxfordshire, England



Foams produced by *in-situ* Polymerisation at **St Andrews** for Joint experiment on **OMEGA laser at Rochester University**, Louise Willingale, K Krushelnick, A Maksimchuk *Center for Ultrafast Optical Science, University of Michigan, USA.*

Characterization of High-Intensity Laser Propagation in the Relativistic Transparent Regime through Measurements of Energetic Proton Beams
L.Willingale, S. R. Nagel,1 A. G. R. Thomas, C. Bellei, W. Nazarov, R. J. Clarke, A. E. Dangor, R. Heathcote, M. C. Kaluza, C. Kamperidis, S. Kneip, K. Krushelnick,,† N. Lopes, S. P. D. Mangles, P. M. Nilson, and Z. Najmudin, **Physics review Letters, March, 2009**, **DOI: 10.1103/PhysRevLett.102.125002**

Foam-filled at an angle

Liquid precursor acrylate solution If there is a film (green)
Fig1A

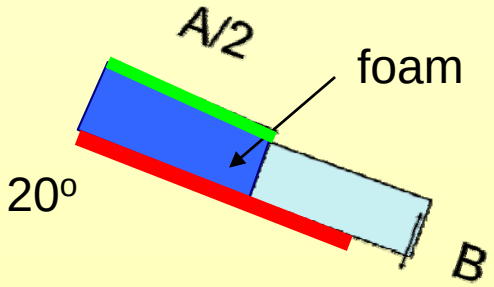
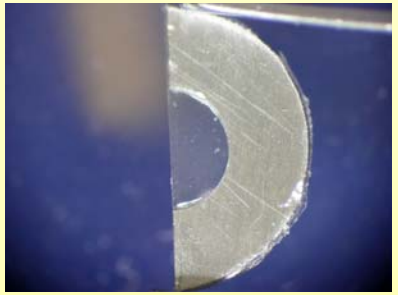
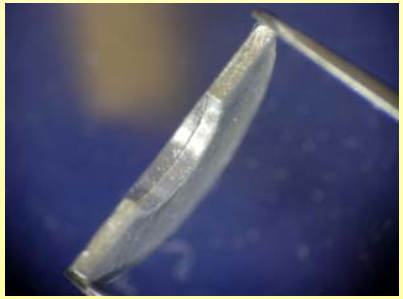


Fig. 1A





If there is no film on the top,
Then you get a meniscus Fig 1B
Where you can manipulate the angle of the foam.

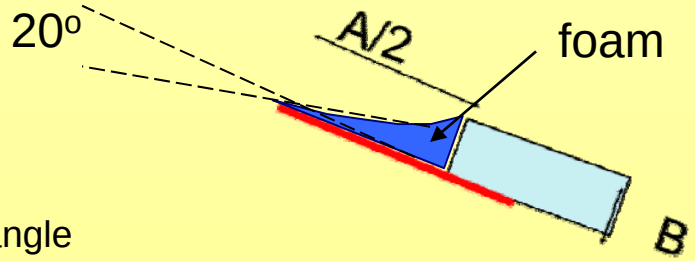


Fig 1B

3.5 mm polyimide tube filled with Zr doped acrylate

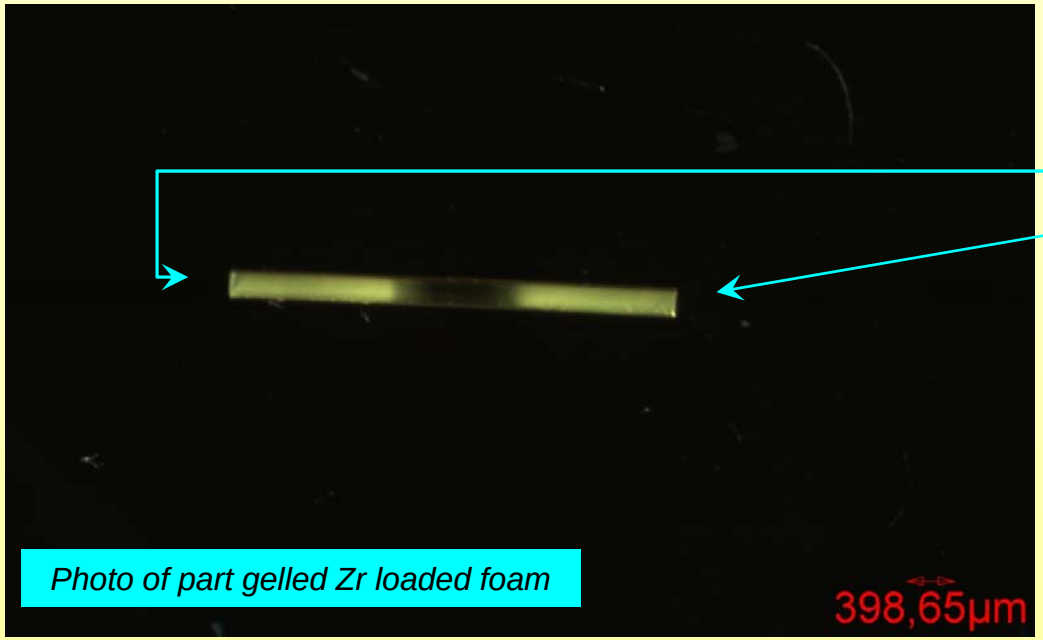
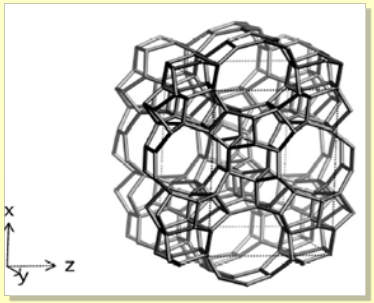


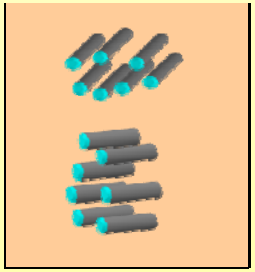
Photo of part gelled Zr loaded foam

UV Light is illuminated from the ends

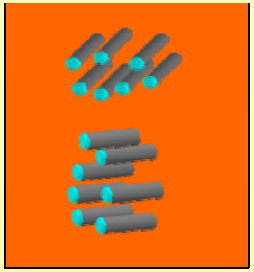
The middle section is not polymerised. UV light is illuminated from the open ends and polymerisation starts from the ends and propagates through the liquid. UV does not penetrate through the polyimide tube,

Templated Resorcinol Formaldehyde foams

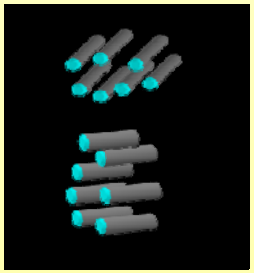




ZEOLITE Suspended in RF solution

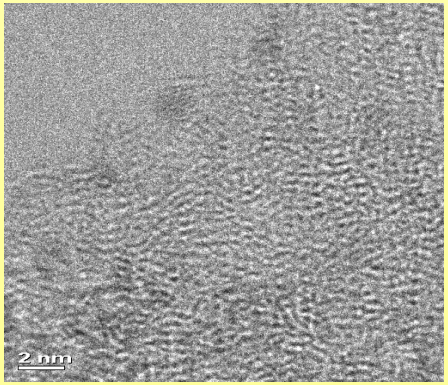


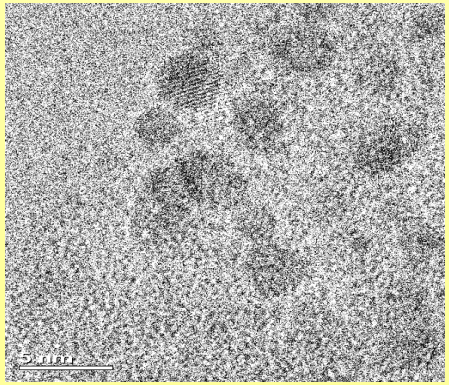
Solution polymerised with ZEOLITE Suspended



RF Resin containing ZEOLITE carbonised

ZEOLITE removed





Old foams – Revisited

- Recent variation and combinations of surfactants in HIPE has reduced its pore size
- Using RAFT (Reversible Addition Fragmentation chain Transfer) reagents also demonstrated interesting results. Pore morphology has changed

Future challenges in target production

- Combinations of different foams, assembled side by side in a target or embedded in each other
- Foams formed against extremely thin foils (nanometers thickness)
- Complicated geometries as target designs evolve

Acknowledgements

- AWE for financial support
- All members of target fabrication laboratory at AWE

Thank you For Listening