GDP Overcoating with a Mass-Production System

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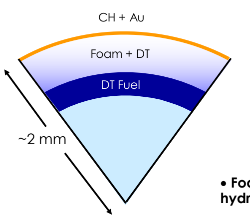
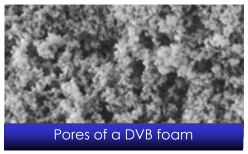
IFT\P2006-070

1 The HAPL target fab program is developing a high gain target with a smooth, gas-tight, conformal overcoat.

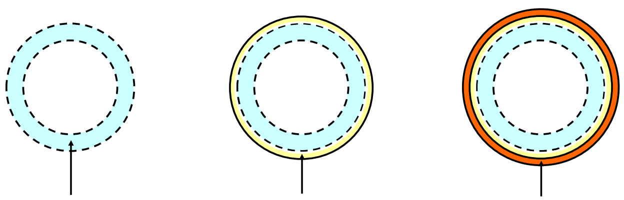



Pores of a DVB foam

- Foam layers are required to be low density pure carbon and hydrogen.
- Divinyl benzene (DVB) has a pore size of 1-3 microns, so it requires a permeation barrier to cover the pores.
- Needed are 500,000 of these targets a day.

2 Using glow discharge polymer (GDP) for a permeation barrier.

- One strategy to achieve this is to have a thin PVP coat layer that is deposited at oil-water interface at the wet stage, followed by a 2nd coat of GDP to seal.
- We think this will work because we know GDP can seal "cracks" if they are less than about 0.1 microns in size (experience with resorcinol formaldehyde (RF) shells).



DVB foam with pores — PVP added to fill pores — GDP coat for permeation barrier

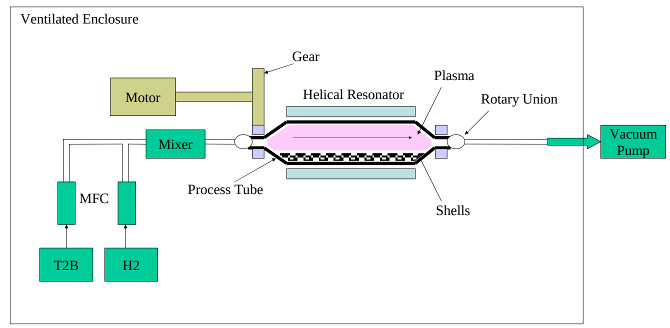
3 We have experience coating with GDP on a small scale, but need to produce 500,000 targets a day.

- The current GDP coaters use pans to hold the shells.
- These pans can typically hold 8-10 4mm shells for a coating run, and can hold about thirty 1mm shells.
- Typical coating rates for shells in the bounce pan coaters are ~0.3 μm/hr.
- The shells are agitated by tapping the pan with a rod connected to an electrically actuated solenoid.

- We have a lot of experience with gas tight GDP if we can get the under-layer smooth enough.

4 New mass-production system is designed to coat many more shells in a single coating run.

- Current bench top setup can coat 100's of shells at a time.
- Concept can be scaled up to thousands.
- Shells are located along the inside of a horizontal glass tube.
- The glass tube diameter is ~5.5 inches and the length is ~19.5 inches.
- The shells are agitated by the rotation of the tube allowing the shells to roll gently along the glass floor.



Rotary Kiln

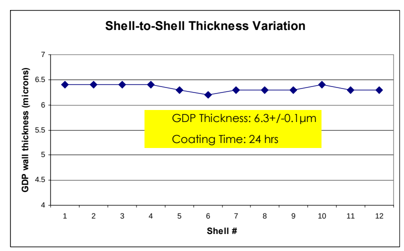
GDP Coater

Incorporating the Rotary Kiln

New changes and challenges are involved in designing a scaled up system.

- Designing a new, larger helical resonator to excite the gas into a plasma.
- Testing radio frequency (RF) power levels to sustain the large volume of plasma.
- Designing proper shielding for the safe control of RF leakage.
- Determining the best gas flow rates and system pressure for such a large volume reactor.
- Creating rotational profiles resulting in uniform coatings and low collision rates between shells.

5 Current results for the new mass-production system are promising for wall uniformity, coating rate, and gas retention.



- Polystyrene, Poly α-methyl styrene (PAMS), RF foam, and DVB foam shells have all been coated with a uniform overcoat.
- Shells have been coated at a rate of ~0.28 μm/hr which would result in a 5 μm wall in under 18 hours.
- Coated RF foam shells and pyrolyzed PAMS shells have been successful in holding gas.
- We are still working towards achieving a gas-tight shell with PVP coated DVB in the new system.