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# Fabrication of Metal-to-Metal Interface Targets for Material Strength Experiments

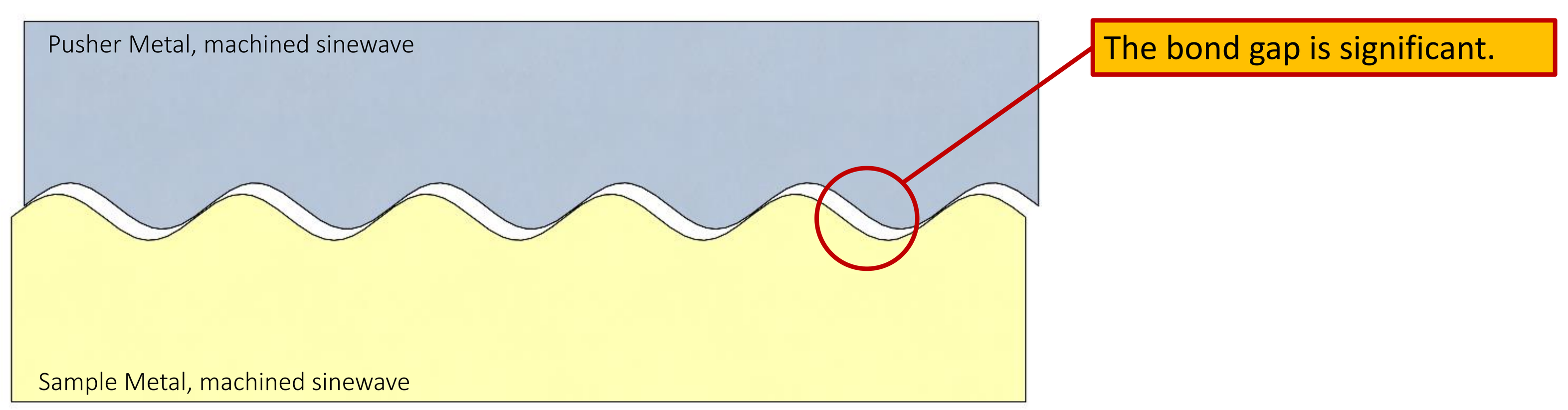
A. Pastrnak, R. Cahayag, R. Chow, T. Siv, D. Skilling, N. Nijem

## Problem Statement

Dynamic strengths of materials at high temperatures and pressures are inferred from the Rayleigh-Taylor instability growth at an accelerated rippled interface comprised of a lower density "pusher" and a higher density "sample" material. Thick or uneven glue bonds with voids at the interface may lead to shock wave reverberation, energy loss, and heating during compression.

### Previous Work

Mechanically bonding machined rippled surfaces, of two opaque metals, is challenging and requires incredibly precise alignment. The glue gap is often difficult to characterize resulting in an uneven bond gap.




## Solution

**PVD coating provides intimate contact between the two metal sine waves**

### PVD Coating

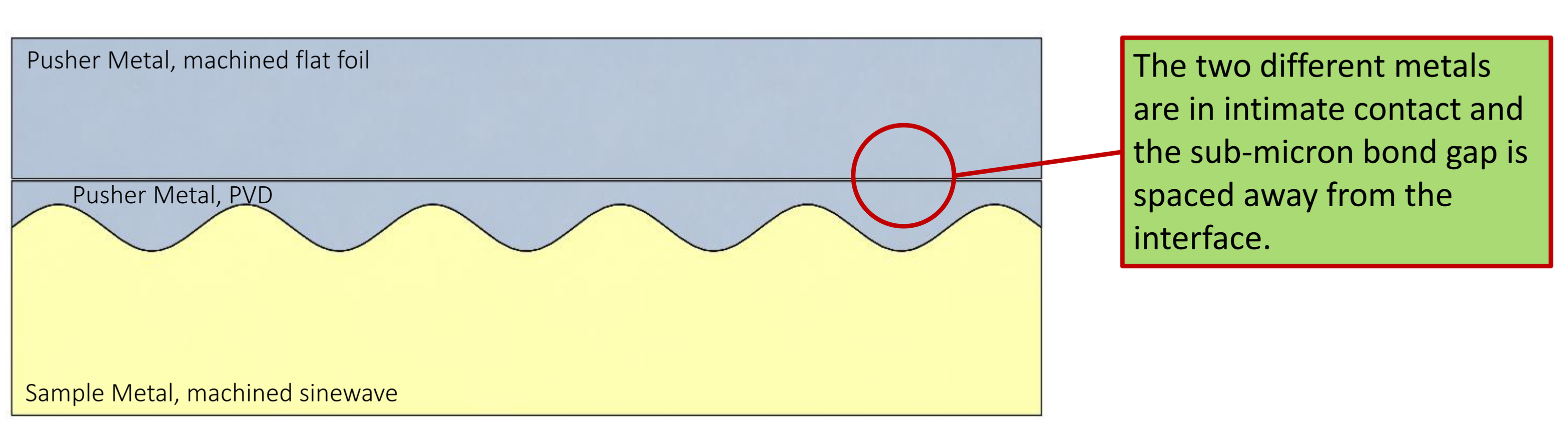
Electron beam physical vapor deposition (PVD) is used to deposit up to 12µm of one metal directly onto the rippled surface of the other, filling the machined perturbation.

### Assembly

The excess coating is machined flat, and an additional layer of the same material is bonded to the flat surface using an assembly station. The resulting target has a sub-micron glue bond. Since the layers are flat, ripple alignment is not a concern.

### Metrology

The profile of the sine wave profile is characterized, and a double-sided measurement technique is used to calculate the bond gap between the PVD coating and machined layers of the pusher metal. Each layer's thickness is characterized more accurately than previous work, thus improving the HED physics simulations.

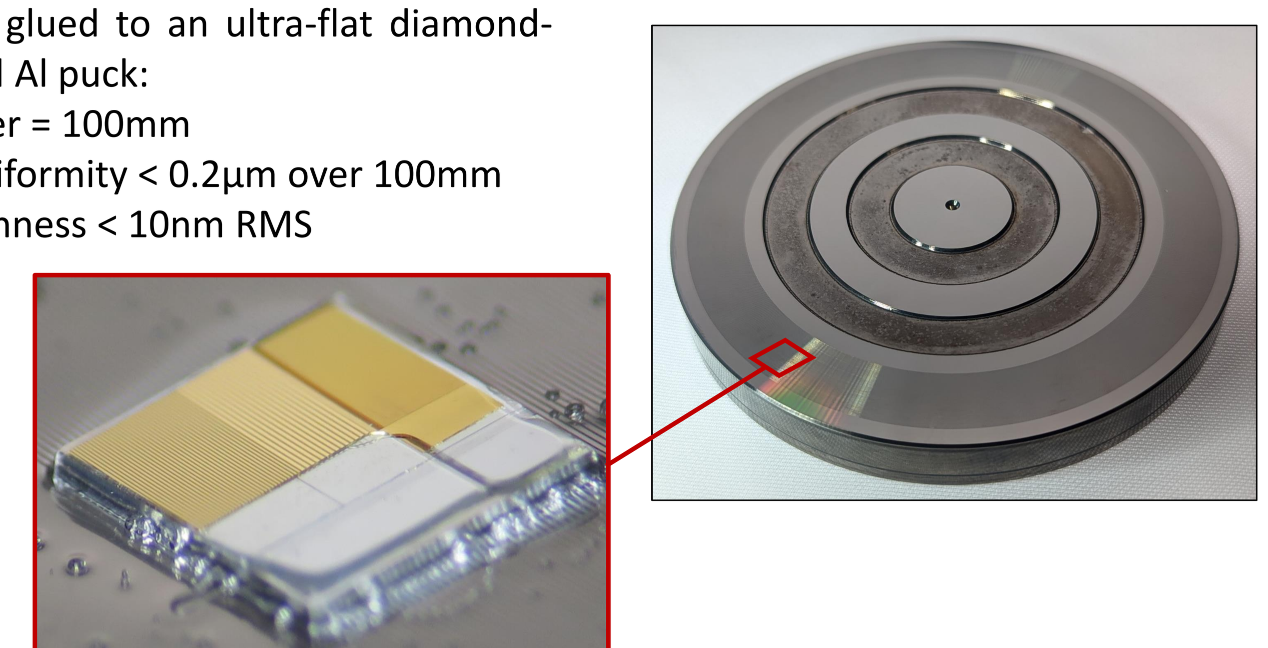


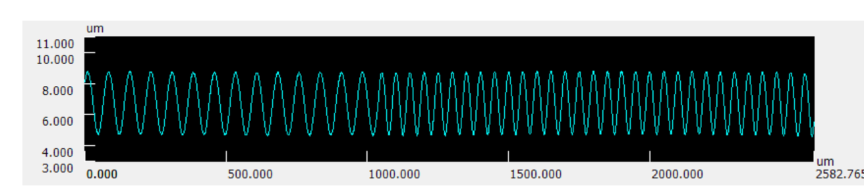

## Precision Machining

The targets are glued to an ultra-flat diamond-turned Ni-plated Al puck:

- Puck diameter = 100mm
- Thickness uniformity < 0.2µm over 100mm
- Surface roughness < 10nm RMS

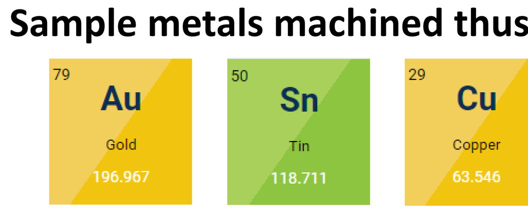
The target is glued to the puck at a radius of 45mm and the sine profile is machined by diamond-turning



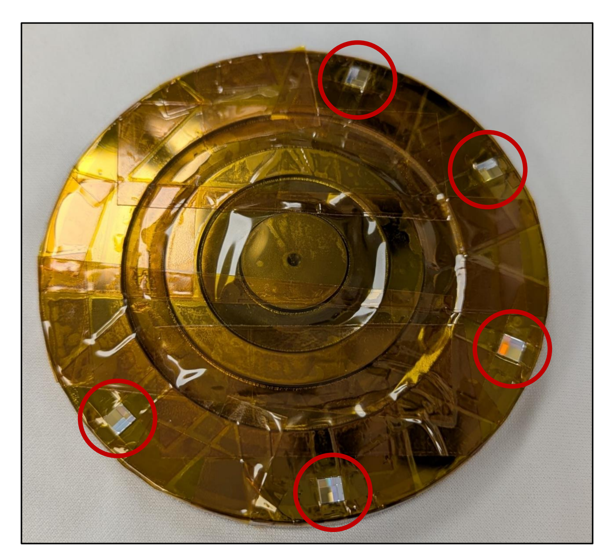


Profile lineout – Keyence VK confocal scan
Amplitude = 2µm, Wavelength = 75µm & 50µm shown

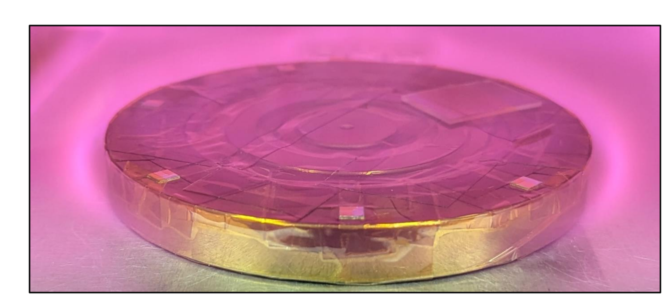
**Sample metals machined thus far**




## PVD Coating

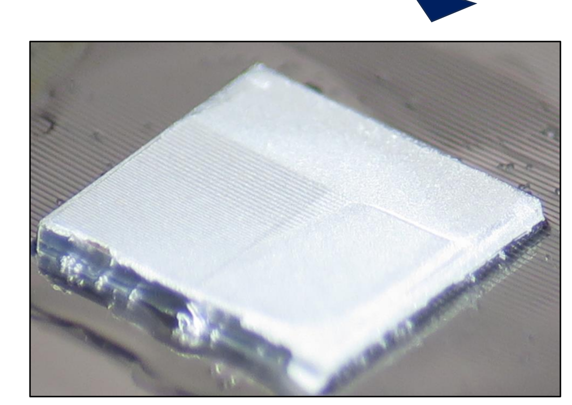


The diamond-turned puck is masked with Kapton tape except for the 5 targets shown.

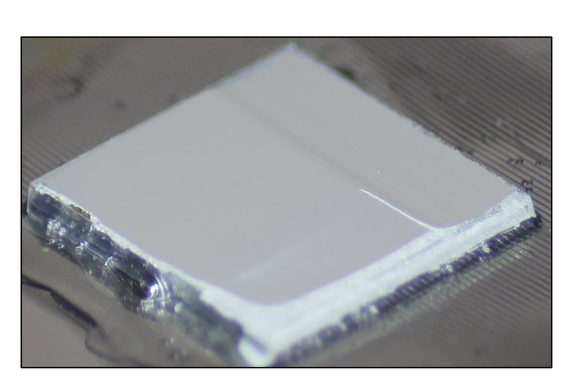


The masked puck is plasma-treated to improve the adhesion of the PVD coating.

12µm of the pusher metal is deposited by e-Beam evaporation.

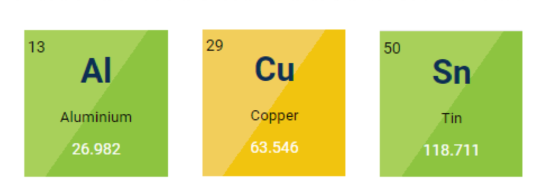


The entire surface of the target is coated with the pusher metal.

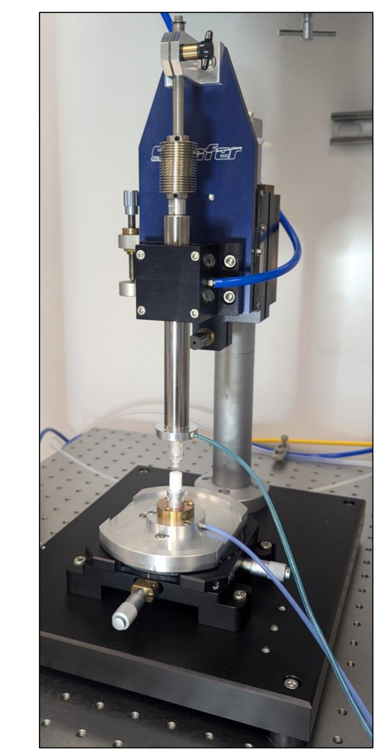


The puck is placed back on the diamond-turning lathe and the PVD coating is faced ultra-flat.

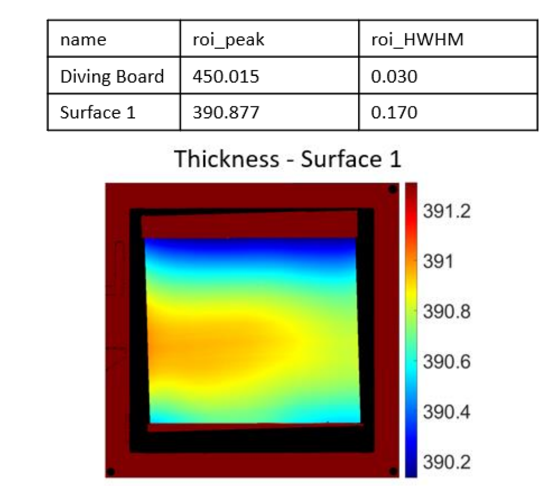
**Pusher metals coated thus far**

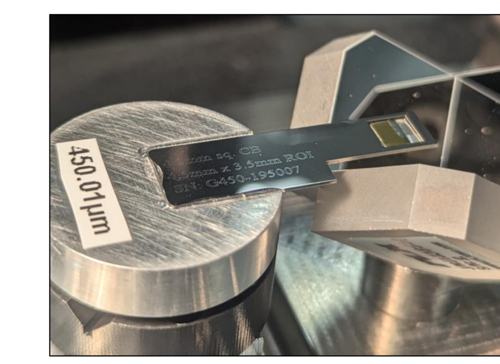



## Assembly



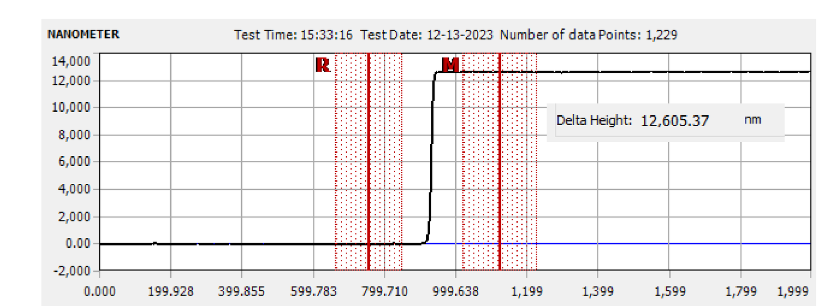
The thick pusher metal foil is double-side measured for thickness and thickness uniformity (process developed by LLNL). The pusher foil is then bonded to the back-machined PVD coating of the same material using an assembly station. The target remains glued to the machining puck throughout this operation.



A "diving board" was designed and manufactured to hold components up to 4.5mm sq.

## Metrology

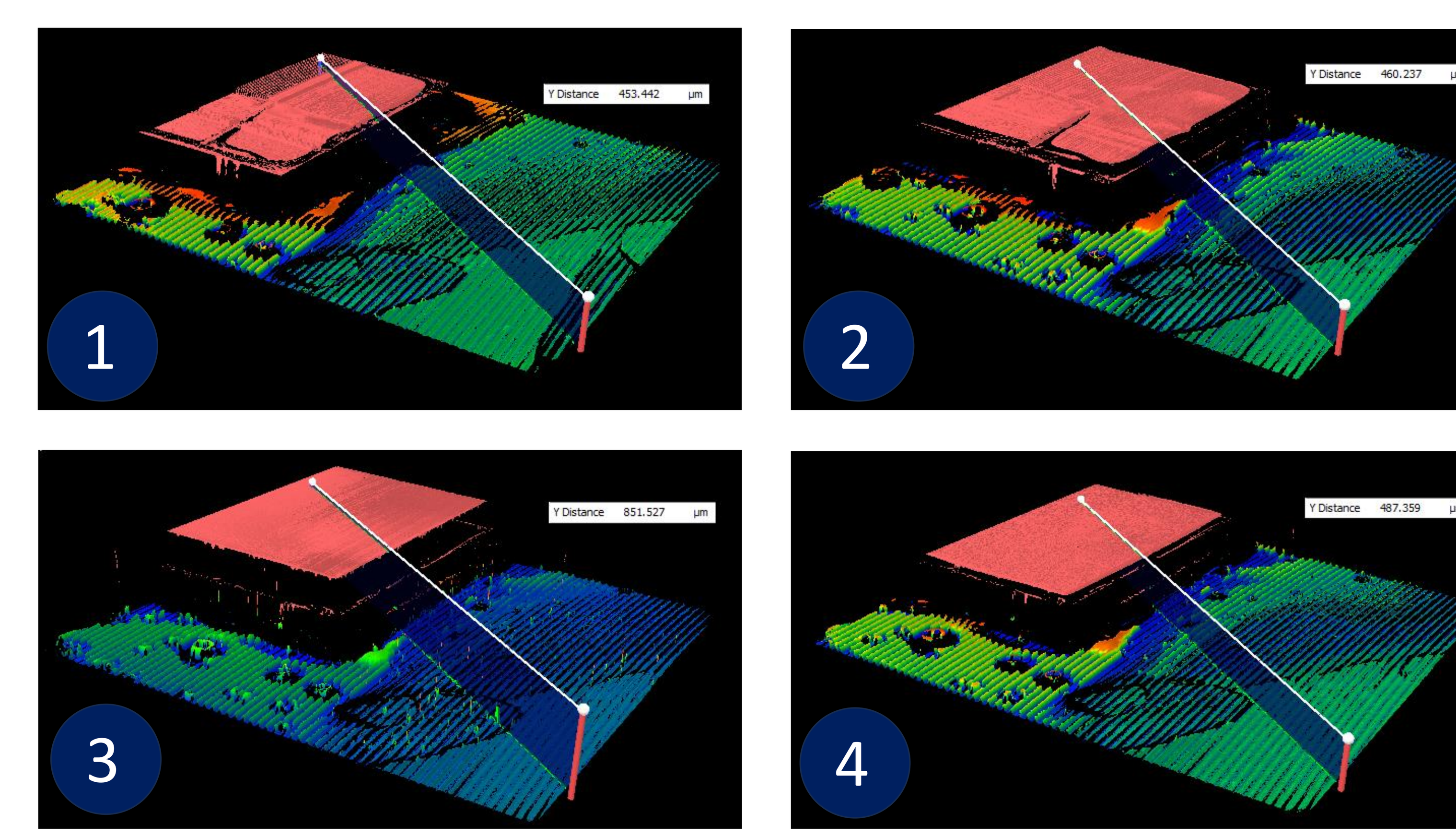


The thickness of the PVD coating is measured with a stylus profilometer scan on a glass witness. The glass witness slides is coated alongside the targets to verify that enough material has been deposited (12.6µm shown).

The bond gap is calculated by subtracting the double-sided measurement result of the pusher metal foil from the assembled target relative to the machining puck.

| Measurement | Measurement Relative to Puck | Result |
|---|---|---|
| 1 | Noncoated sample metal ripples | 453.442µm |
| 2 | PVD coated and back-machined pusher metal | 460.237µm |
| 3 | Thick pusher metal foil assembled to back-machined coating | 851.527µm |
| 4 | Back-machined pusher metal | 487.359µm |

$$PVD\ Thickness = 460.237 - 453.442 = 6.795\mu m\ (to\ midpoint\ of\ sine)$$
$$Bond\ Gap = 851.527 - 390.877 - 460.237 = 0.413\mu m$$
$$Total\ Pusher\ Thickness = 487.359 - 0.413 - 453.442 = 33.504\mu m$$

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