Development of Bosque Shock Imprint and Preheat Targets

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Abstract

Bosque Preheat (PH) studies the expansion of a 2-Photon Polymerization (2PP) lattice structure from hot electron preheat and radiative heat, while Bosque Shock Imprint (SI) measures the imprint of a 2PP lattice structure onto a shock front velocity. Various techniques were used to fabricate components and assemble targets for these campaigns. 2PP structures were designed in nTopology and printed on a Nanoscribe Photonic Professional G2. Anti-reflective (AR) coatings for windows were developed and quantified in-house. Finally, custom vacuum tips were designed to improve handling of oddly shaped components.

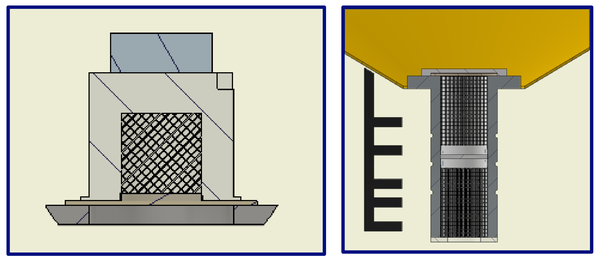


Figure 1: Sliced view of Bosque SI targets (left) and Bosque PH targets (right).

Anti-Reflective Coating Research

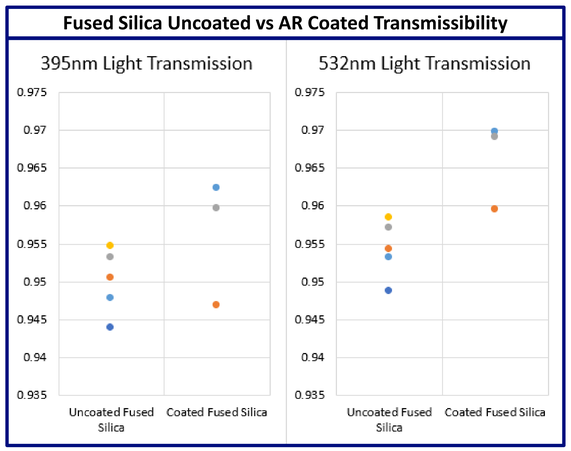
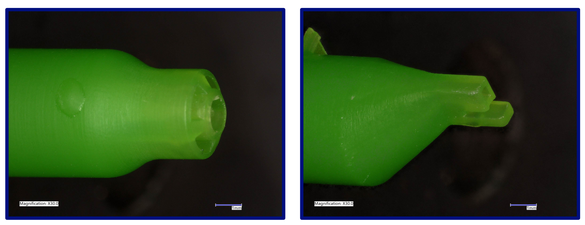


Figure 2: Uncoated and AR coated fused silica samples were tested for transmissibility. Transmission increased with a 95.2nm MgF_2 coating.

Vacuum Tip Design

Vacuum tips designed to contour specific parts were printed through Protolabs using Microfine Green resin

Figure 3: Using a contoured vacuum tip designed to hold the gold cone for Bosque PH (left) and the shock tube for Bosque PH (right) decreased assembly time and increased placement accuracy.



Lattice Development

Bosque SI and PH utilize unique latticed experimental packages

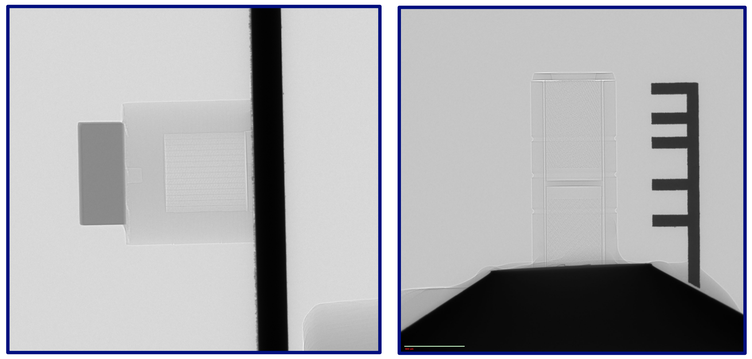


Figure 4: The lattices used in Bosque SI (left) and Bosque PH (right) have unique developmental challenges.

nTopology: A Powerful Lattice Modeling Software

Advantages over Traditional CAD Software

1. Fast rendering of complex parts
2. Ability to change multiple parameters with one variable
3. Less prone to crashes

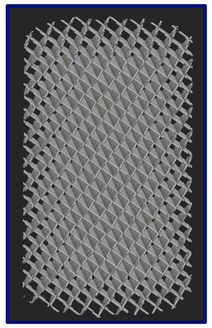
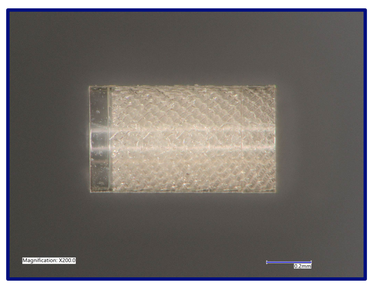


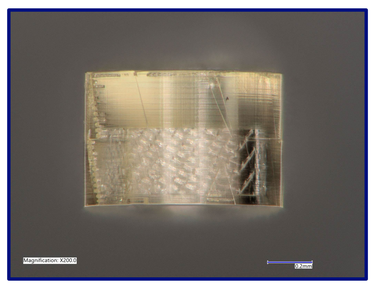
Figure 5: Rendering this lattice took hours in Autodesk Inventor but rendered almost instantaneously in nTopology.

Printing on a Nanoscribe Photonic Professional GT2

Lattice Structure Definition



Bosque Preheat
40 um x 40 um x 40 um cubic unit cell
5 um diameter circular strut



Bosque Shock Imprint
50 um x 50 um x 50 um cubic unit cell
5.2 um x 5.2 um square strut

Design Challenges

Bosque Preheat

- **Challenge:** Not possible to print a 2PP witness disk in the center of the lattice with a gap of 100um from the lattice structure
  1. If printed vertically, the witness would sag due to lack of supports
  2. If printed horizontally, the structure would not adhere to the printing slide
- **Solution:** Print the lattice in three pieces with a thin 'sleeve' on the outside that supports witness from both sides

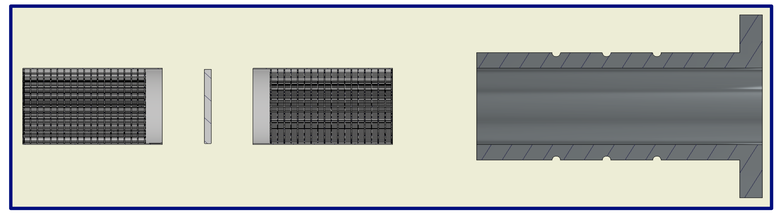


Figure 6: The lattice was assembled in a Be shock tube by inserting each piece individually and relying on the 'sleeve' for support.

Bosque Shock Imprint

- **Challenge:** 2PP witness piece requested to be as flat as possible
- **Solution:** Printing the packages with the witness side on the printing slide reduced the quality of the witness surface

Figure 7: A Zygo surface scan of the witness surface measured a peak to valley height of 7 um (below).

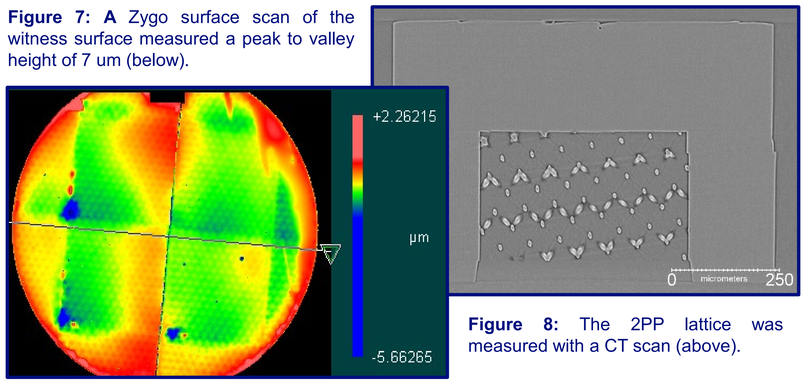


Figure 8: The 2PP lattice was measured with a CT scan (above).

Future Improvements

Bosque PH 25A and SI 25A are scheduled for shot days in December and January

1. **Bosque PH:** Minimize clearance between lattice and shock tube through iterative printing
2. **Bosque SI:** Improve quality of 2PP witness surface by changing orientation and print settings
3. Improve characterization of lattices by better implementing CT scans and Density Characterization Scans
4. Continue characterization of various window types and coating thicknesses

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