Thin Film Metrology and Processing Improvements at Luxel Corporation

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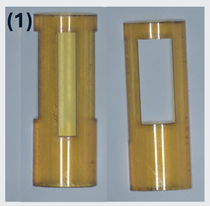
50th LUXEL 1974-2024 ANNIVERSARY

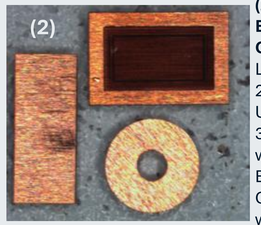
Component Fabrication

UV Laser Machining

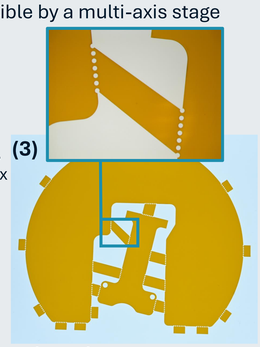
- 3Watt, 20µm spot size, 355nm UV-laser
- Marking area: 170mm x 170mm. Larger areas are made possible by a multi-axis stage
- Rotary axis enabling milling of curved surfaces



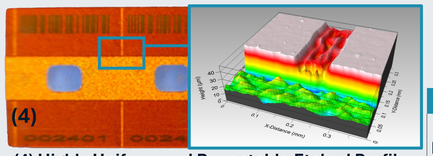
(1) 4th Axis Milling
5mm long polyimide (PI) tubes with LEH windows



(2) Metal Etching and Cutting
Left: 4.8mm x 2mm rectangle, Upper: 4.5mm x 3mm rectangle with step
Bottom: 3mm OD x 1mm ID washer



(3) High Precision over Large Area
170mm x 75µm thick Kapton with 750µm diameter perforations



(4) Highly Uniform and Repeatable Etched Profiles
Luxel's GridTape® - 4mm wide x 30µm deep trough etched into the backside of the tape as well as a 10µm deep vent path every 6mm.

Test Verified Materials		
Metals including:	Al, Cu, Ti, Ta, Mo, Zr, Sn, In, 304 SS	Up to 300µm
Plastics including:	CH, PET, PI	Up to 500µm

Target Assembly Workflow

Component Fabrication
Milling, Turning, Drilling
UV Laser Machining

Fabrication of Ultrathin Freestanding Films
Polyimides: 50nm – 5µm
Metal Coatings: 3nm – 5µm

Component Inspection
Visible Light Microscope
Multi-Sensor Measurement System
White Light Interferometer

Film Thickness Verification
Stylus Profilometer
Reflectometer
Ellipsometer

Target Assembly

Pressure Testing
Low Pressure Bleed Down
Helium Leak Detection
In-situ Deflection Measurements
High Pressure Bleed Down Testing
Destructive Analysis

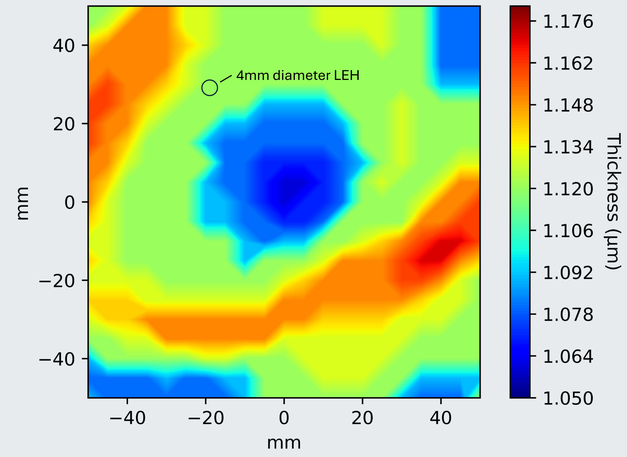
Auxiliary Metrology Tools
Confocal Profilometer
Visible Light Microscopes
Infrared to UV Spectrometers
White Light Interferometer
Scanning Electron Microscope
Energy Dispersive X-ray Spectrometer

Delivery of Laser Targets

Film Thickness Verification

Ellipsometer

- Ellipsometry enables non-contact measurements of transparent films
- Standard material non-uniformity is ~5% across a 140mm diameter area
- Large area film mapping and precise measurement of smaller films with tighter tolerances.



Component Inspection

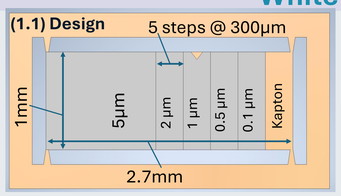
Visible Light Microscope	Multi-Sensor Measurement System	White Light Interferometer
Qualitative inspections of freestanding films	300x300mm measurement area	Areal roughness characterization
Quality imaging	Dimensional inspection	Step height
Quick dimensional checks	Large area flatness verification	Quantitative texture and form
Defect characterization	Programmable for high throughput	Edge roll-off characterization

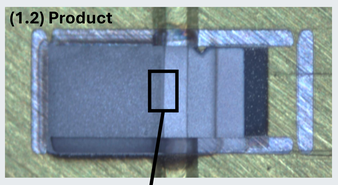
Pressure Testing

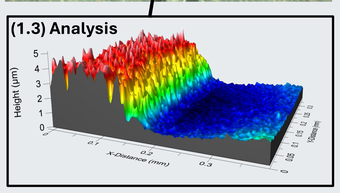
Pressure System	Test Type	Volume (L)	Sensitivity (Torr*L/s)	Frame Type	Connection	Pressure Limit (atm)	Gases
Gas pipe Test System	Rate-of-fall	1.38E-03	5E-05	Gaspipe with fill tubes	PTFE tubing	5.0	Air, N_2
NIF Test System	Rate-of-fall	8.24E-03	5E-05	Planar	O-ring	27.0	He, Air, N_2, Ar, Kr
				Non-Planar	Epoxy or VCR		
	Helium Leak Detection	N/A	5E-11	Planar	O-ring	2.0	He
				Non-Planar	Epoxy or VCR		

Auxiliary Film Metrology

White Light Interferometry







(1) PVD Coating Characterization
A multi-step Sn coating is analyzed for step height, and roll-off to meet tight spatial tolerances.

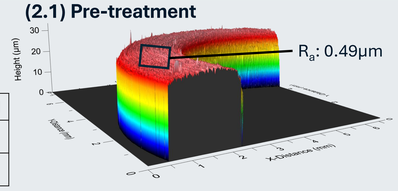
Dimension	Target	Measured
Step Height	3µm±0.3µm	3.09µm
Roll-off	<50.0µm	36.4µm

(2) 3D Roughness Analysis
LEH washer surfaces are analyzed to optimize treatment processes for maximum LEH window adhesion.
1mmx1mm Area Measurements
2.1 : Pre-treatment: 0.49µm
2.2 : Post-treatment: 2.93µm

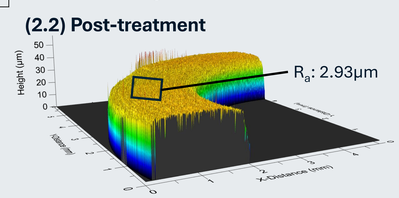
(3) Large Area Topography
Stitch-scanning allows for large area mapping and topographical maps. A storm window's waviness and ID transition is analyzed via line scan of a stitched map.

5.79mm ID x 100nm LUXFilm® Polyimide / 40nm Carbon.

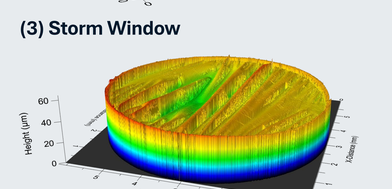
(2.1) Pre-treatment



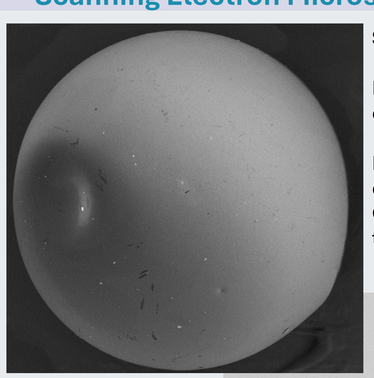
(2.2) Post-treatment



(3) Storm Window



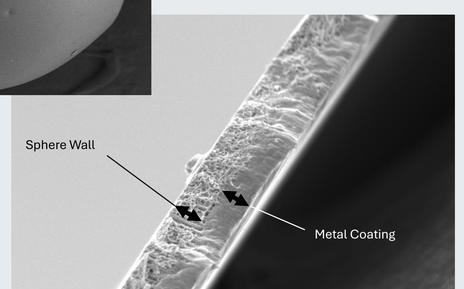
Scanning Electron Microscopy



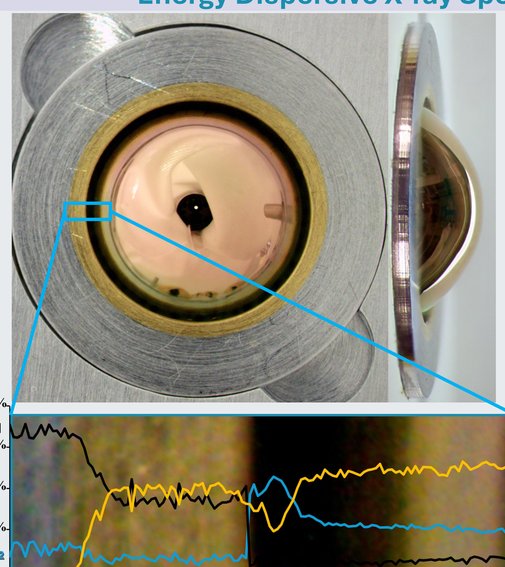
Surface Coating Characterization

Left: 0.5mm diameter metal-coated polymer sphere.

Below: Cross-section view of metal coating on polymer sphere wall. Qualitative assessment of thickness uniformity and adhesion.



Energy Dispersive X-ray Spectroscopy



Spatially Resolved Compositional Analysis

6mm ID 40nm Au-coating on 1.0µm LUXFilm® Polyimide domes.

LUXFilm® Polyimide is shaped into a near-hemispherical shape before the Au coating.

EDS analysis was conducted to evaluate the shadowing effect of the washer during deposition.