Surface Optics Corporation
Protected Silver Coatings
For Large Optics

David A. Sheikh
Surface Optics Corporation
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Large Optics & Silver Coatings

- SOC’s method for coating large optics
  - E-beam evaporation
  - Deposition source on movable stage
  - Ion assisted deposition (IAD)
    - Reactive compounds (nitrides, oxides)
    - High density coatings

- Silver coatings
  - LLNL patented silver coating (based on sputtering)
Government Funded R&D Mirror Coating Projects at SOC

- **AFRL** - $850k; High-Energy Laser Coatings On Polymer Membranes
- **NASA** - $700k; Non-Tarnishing Silver for Space Telescopes
- **MDA** - $1.1M; X-Ray Hardened Mirror Coatings for Missile Interceptors
- **NASA** – $170k Large Optical Mirror-Filter for Laser Communication
- **Thick Silicon Cladding For Optical Finishing ($400k)**
Examples of SOC Space Flight Coatings

- Kepler Space Telescope Primary Mirror (1.5-m)
- M^3 (Moon Mineralogy Mapper)
- Cloud Sat (2-meter RF Reflector)
- WMAP Reflector (Microwave Anisotropy Probe)
- EchoStar (6, 3-meter reflectors)
- Chandra Observatory (collimator plates)
Kepler Primary Mirror
Kepler Mirror – Inspection
SOC’s 3.3-meter Vacuum Chamber
Electron Gun & IAD Platform
Coating Approach - ~30 plume positions, 3-cm steps
Coating Uniformity

Coating Thickness (nm)

Radial Position (cm)

Measured Thickness
LLNL & Kepler Coating Design

**Basic Protected Silver**

- $\text{Si}_3\text{N}_4$
- Ni-CrN$_x$
- Ag
- Ni-CrN$_x$
- Mirror Surface

**Protected & Enhanced**

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<th>Reflection Enhancement</th>
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<tbody>
<tr>
<td>L-Oxide</td>
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Protected Ag
Nickel Chromium Nitride

- Thickness is critical for durability
- Thickness is difficult to control over large area
- Highly absorbing in blue and UV
Enhanced Silver Reflectivity
Space Radiation Test (GEO)

SOC - Silver Coating

LiF Standard
Limitations of Coating Design and Coating Method

- Hard to control thickness of NiCrNx over large area
- Too much NiCrNx leads to low reflectivity and too little leads to poor durability
- LLNL design requires exceptionally good vacuum
- SOC’s coating method currently limited to optics less than 1,500 lbs
- Top loading system is awkward
- SOC’s coating method points up and not down