

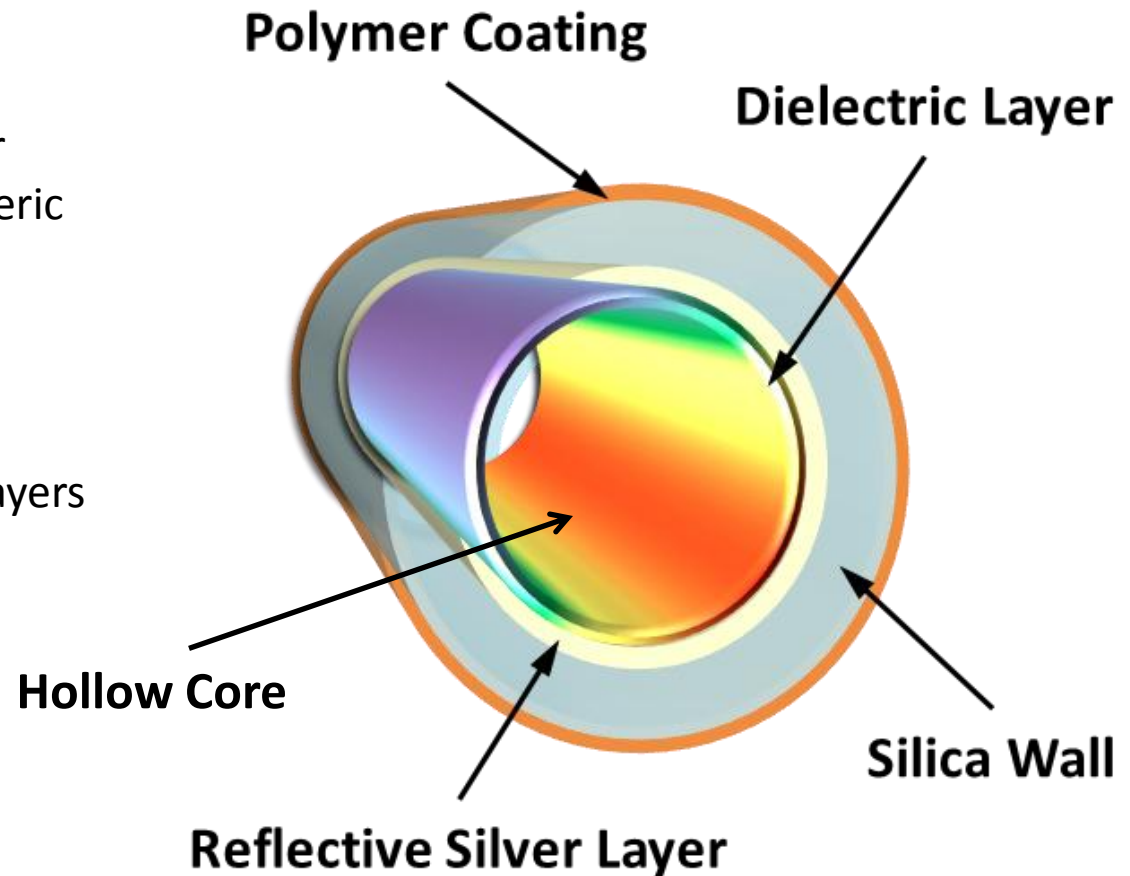
Optical Dielectric Thin Film Design in Hollow Glass Waveguides

**Infrared Laser
Delivery & Spectroscopy
Applications**

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Hollow Glass Waveguide Design

- HGW structure consists of a continuously drawn, high purity silica capillary tube
- An outer protective polymer coating to prevent atmospheric degradation.
- Reflective silver layer
- Various thin film dielectric layers i.e AgI, CdS, PbS



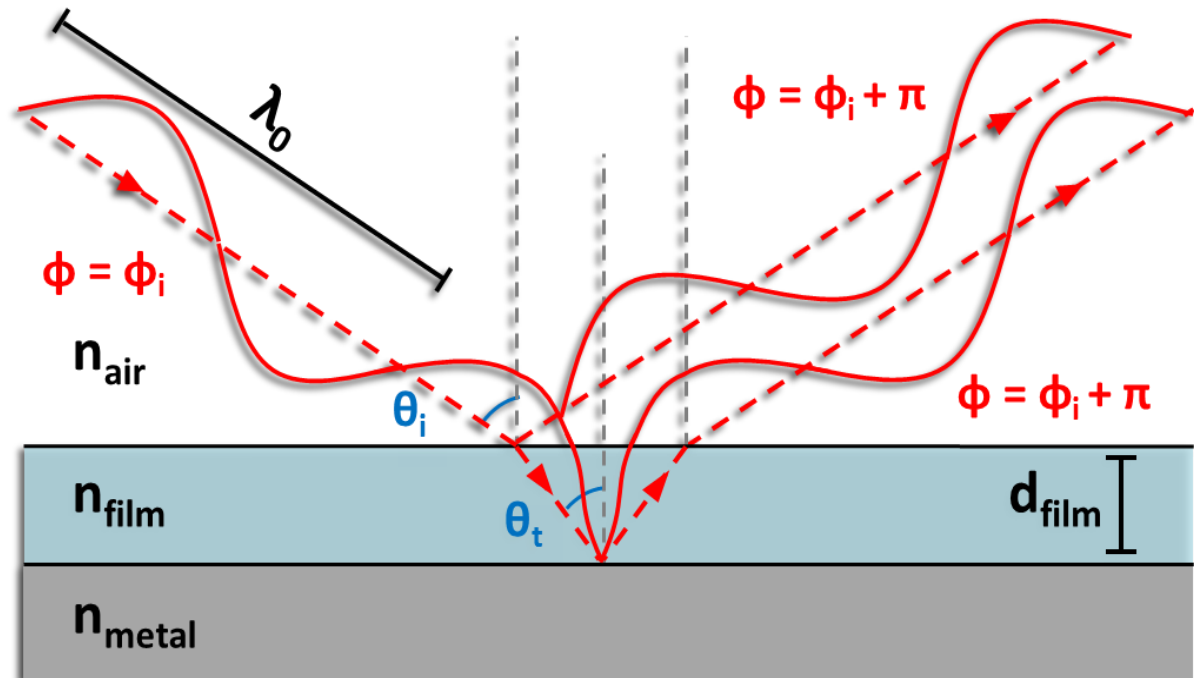
Thin Film Interference Effect

- The refracted beam constructively interferes with the reflected beam producing less absorbance and higher transmission.

Thin Film Thickness is calculated by:

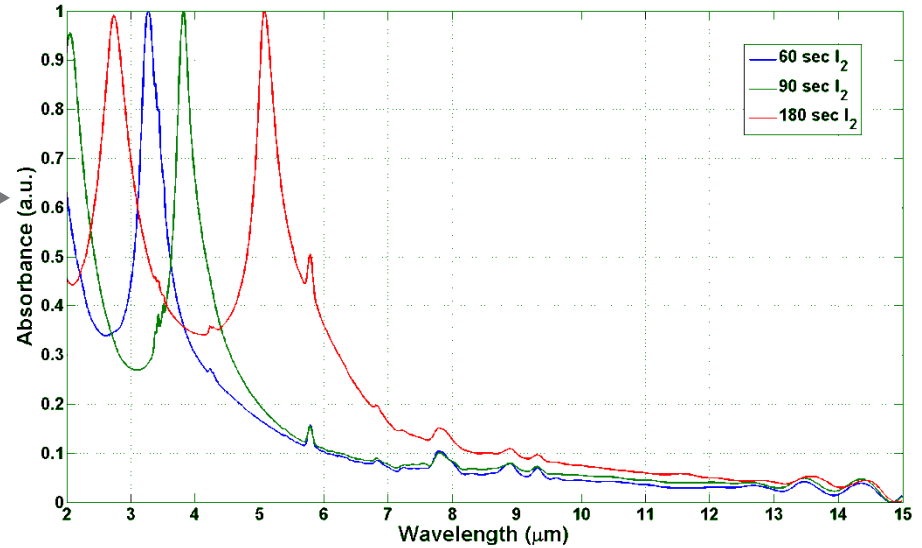
$$d_{film} = \frac{1}{2n_{film} \cos \theta_t} \left(\frac{\lambda_0}{4} \right)$$

Actual film thickness is directly related to deposition time.



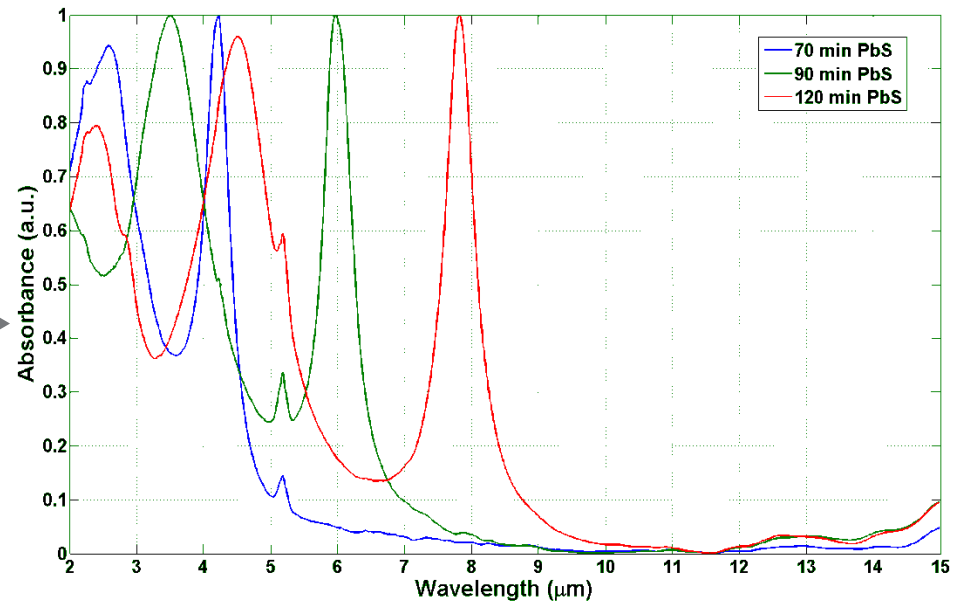
AgI and PbS Thin Films

Silver
Iodide



- Spectral shifts due to variation in deposition time.
 - This is due to an increase in thin film thickness.

Lead
Sulfide



- Altering deposition time allows for customization of optimal transmission range

Thin Film Effect on Transmission

Beer Lambert Absorbance Coefficient Equation

Transmission in hollow glass waveguides is measured using the “cut-back” method.

$$\alpha = \frac{10}{L - s} \log_{10} \left(\frac{P_{in}}{P_{out}} \right)$$

Absorption coefficients for various thin films

| | d_{film} (μm) | α (dB/m) | $\Delta\alpha$ (dB/m) | T (P_{in}/P_{out}) |
|---------|-------------------------------------|-----------------|-----------------------|------------------------|
| Ag Only | N/A | 3.823 | N/A | 51.4% |
| Ag/AgI | 0.384 | 0.057 | -3.766 | 97.6% |
| Ag/CdS | 0.496 | 0.097 | -3.734 | 94.35% |
| Ag/PbS | 0.233 | 0.041 | -3.782 | 99.37% |

Applications

- **High Power Laser Delivery**
 - Upwards of 1 kW
- **Medical Surgery**
 - Precise manipulation of laser beam
- **Spectroscopy**
 - Gas Sensing



**Commonly Used Thin
Film is AgI**

References/Acknowledgments

Optical Dielectric Thin Film Design in Hollow Glass Waveguides (HGWs) for Infrared Laser Delivery & Spectroscopy Applications

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