CASE STUDY

Sputtered Optical Filters for Satellite Laser Communications

OVERVIEW

Chroma Technology worked with a satellite communications developer to manufacture optical filters for free-space optical (FSO) laser communication including sputtered bandpass filters, beamsplitters, and a solar filter to reflect broadband thermal energy while maintaining C-band transmission. To address the solar filter requirement, Chroma developed a gold induced-transmission filter design and delivered optics that passed adhesion and abrasion testing per ISO 9211-4 and MIL-C-48497A.

- **Industry**: Aerospace / Satellite Communications
- **Application Area**: Free-space optical (FSO) laser communications
- **Technology Focus**: Sputtered bandpass filters, beam-splitters, and gold induced-transmission filters

> *The filters had to pass laser signals at precise wavelengths while rejecting thermal energy across the full IR spectrum.*

CHALLENGE

The client required bandpass filters isolating Tx and Rx channels near 1545 nm and 1560 nm with low phase retardance, beamsplitters with tight cut-on tolerances, and a solar filter transmitting in C-band while reflecting thermal radiation from the Sun and Earth through the deep IR. No off-the-shelf solution could meet this combination.

SOLUTION

Chroma addressed all three filter requirements using sputtered coatings. Bandpass and beamsplitter designs achieved steep edges, tight CWL tolerances, and controlled polarization performance. For the solar filter, Chroma developed a hybrid gold induced-transmission design pairing a dielectric bandpass filter with an ultra-thin gold layer to reflect thermal energy while transmitting in the C-band. A proprietary etch-back process produced continuous layers at approximately < 10 nm.

> *Sputtered coatings addressed each filter requirement — from narrow channel isolation and polarization control to broadband solar rejection.*

KEY FEATURES

High C-band transmission
Greater than 92%T in C-band, exceeding theoretical predictions.

Broadband thermal rejection
Ultra-thin gold layer reflects from visible wavelengths through the deep IR, managing solar and Earth thermal loading.

Narrow bandpass precision
Steep edges and tight CWL tolerances for clean Tx/Rx channel isolation.

Coating durability
Sputtered construction with demonstrated adhesion and abrasion resistance.

CASE STUDY

SWIR Optical Filters for Pipeline Contaminant Detection

IMPLEMENTATION

1. Define spectral requirements for each filter type
2. Develop etch-back process for continuous ultra-thin gold layers
3. Characterize thin metal optical constants and iterate design via optical monitoring
4. Validate filter spectral performance and coating durability to strict ISO & MIL standards

RESULTS

- Bandpass and beamsplitter filters met edge steepness, CWL, and polarization targets
- Solar filter exceeded 92%T in C-band, surpassing theoretical predictions
- Passed adhesion and abrasion testing per ISO 9211-4 and MIL-C-48497A

CONCLUSION

This project demonstrates how FSO laser communications can demand multiple filter types with distinct engineering requirements. Achieving precise channel isolation, low phase retardance, and broadband solar rejection each called for a different design approach — with the gold induced-transmission filter requiring custom process engineering to produce consistent ultra-thin gold layers. Together, the filters met the spectral precision and durability space-based laser communications demand.