

Optics for earth observation applications

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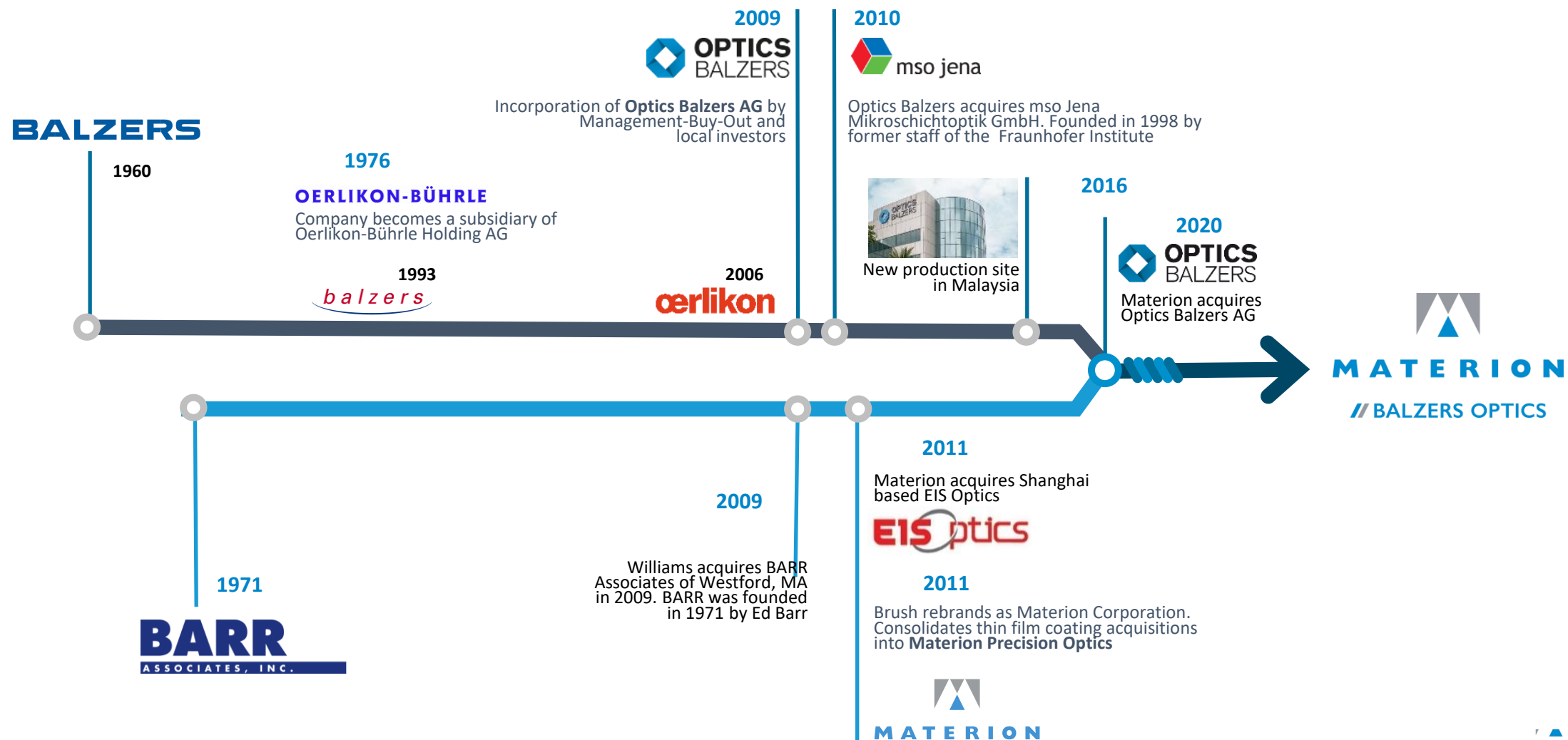
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MATERION

// BALZERS OPTICS

Our History



Outline

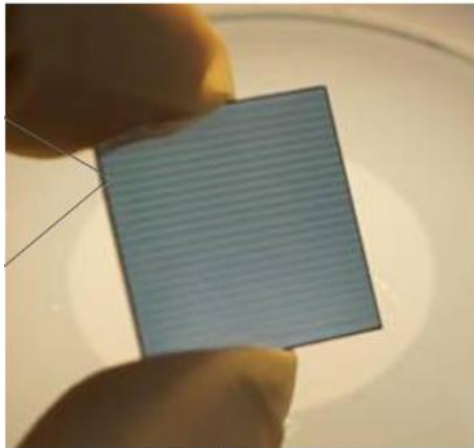
- ✓ **Multiband arrays : Monolithic (incl. OSF Order Sorting Filter) ,
Butcher Block**
- ✓ **Other : Graded Filters, Beam Splitters, Mirrors**
- ✓ **Summary**

Monolithic filter arrays

■ Examples of monolithic filter arrays:

CO2M MAP filter

- 156 filter stripes
- 100 μm width of each filter channel



from Spilling et al. 2021

ELOIS Order sorting filter

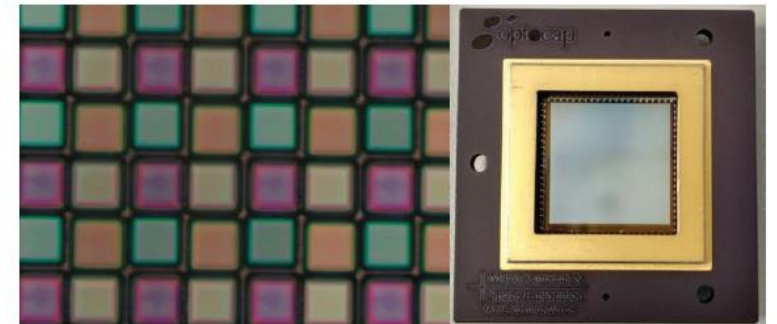
- 3 filter zones + black mask



from Borguet et al. 2021

JUICE monitoring camera filter

- 4 color filter array (1024x1024 pixels) on CMOS wafer
- 18 μm x 18 μm filter size

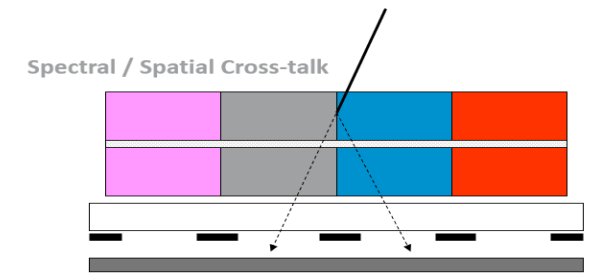
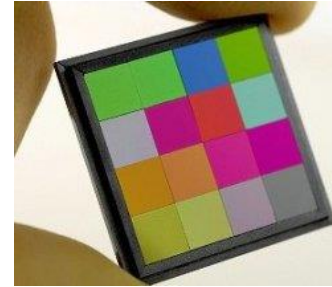
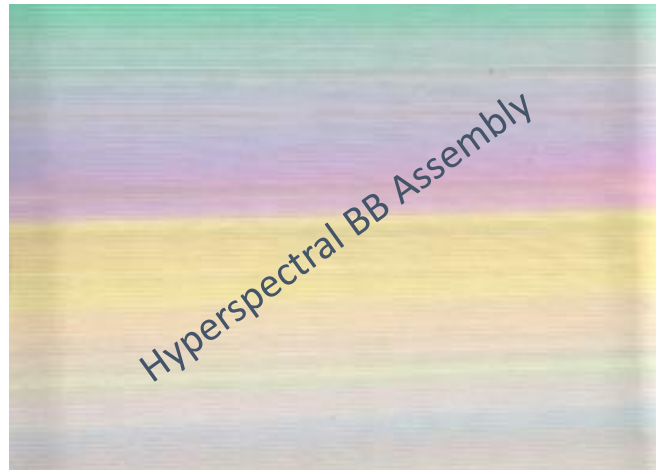
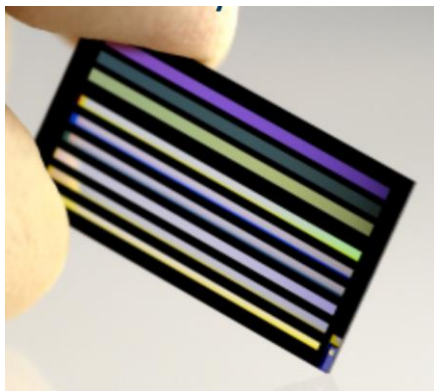


from Adamiec et al. 2021

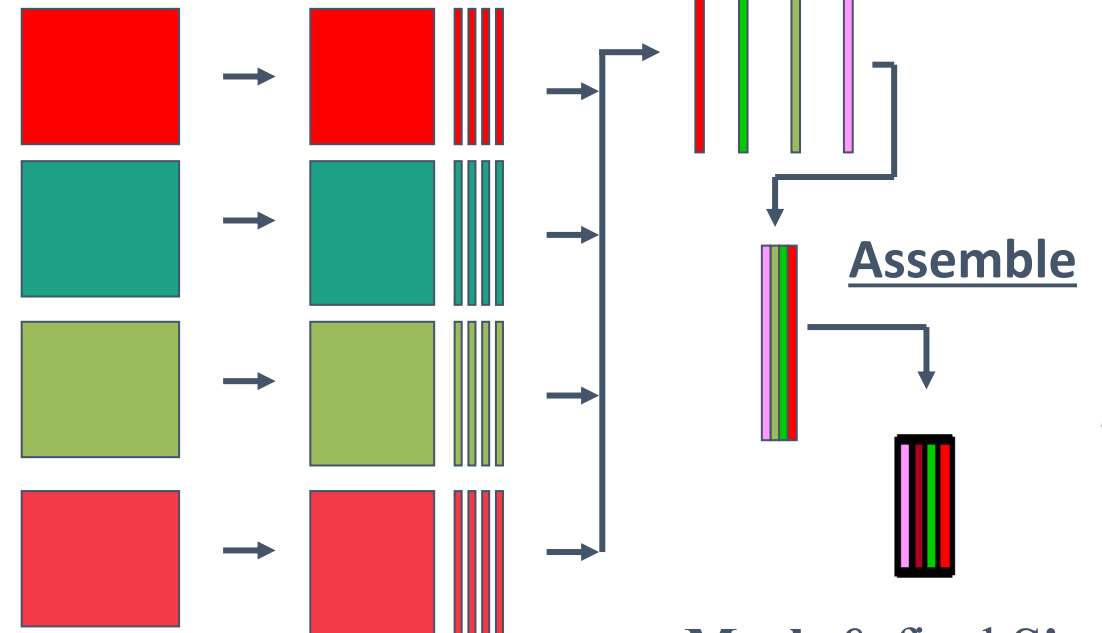
Multi-Spectral Filter Array Types

Butcher Block Assemblies

- Individual filters are sawn into sticks and bonded together
- Multiple Substrate materials – broad wavelength range (180nm – 30µm)
- Nearly unlimited # of bands (> 100 to date)
- Sticks as narrow as 20 um demonstrated
- Sticks length up to 150mm
- Improved straylight / crosstalk control
- Optimal spectral performance – each band manufactured separately



Deposit filters on wafers **Slice** sticks



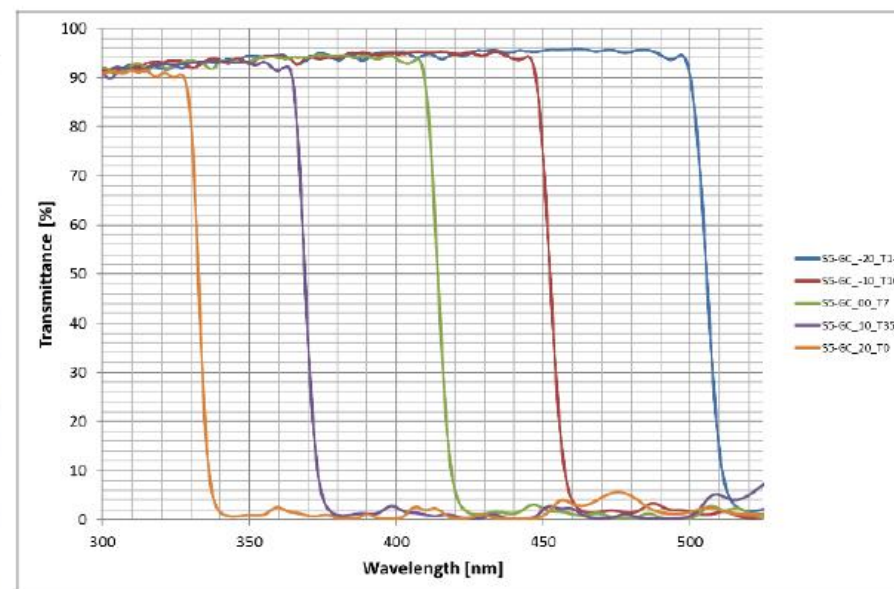
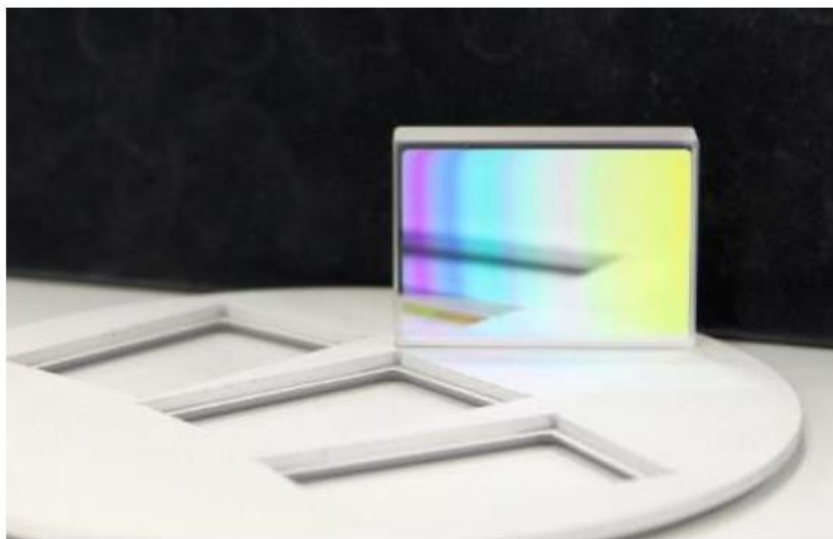
Mask & final Size

Types of Space Coatings

Graded Coatings

Galileo Sentinel-5/UVNS

- IAD short pass filter coating with gradient
- Band edge from 300 nm - 500 nm
- In band transmittance > 90%

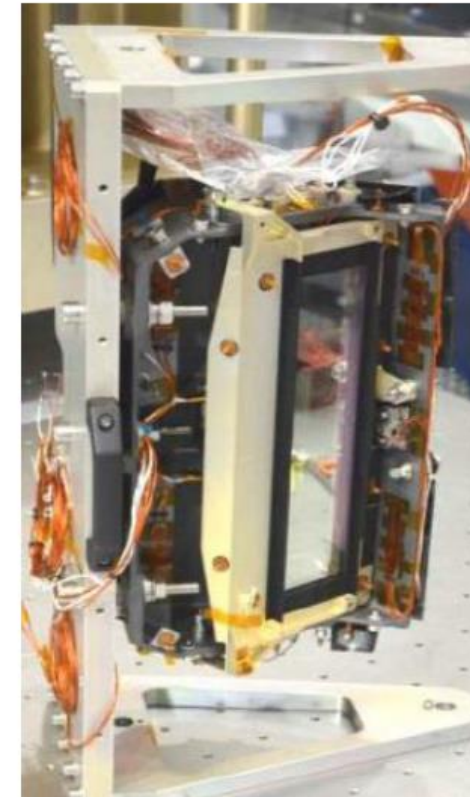
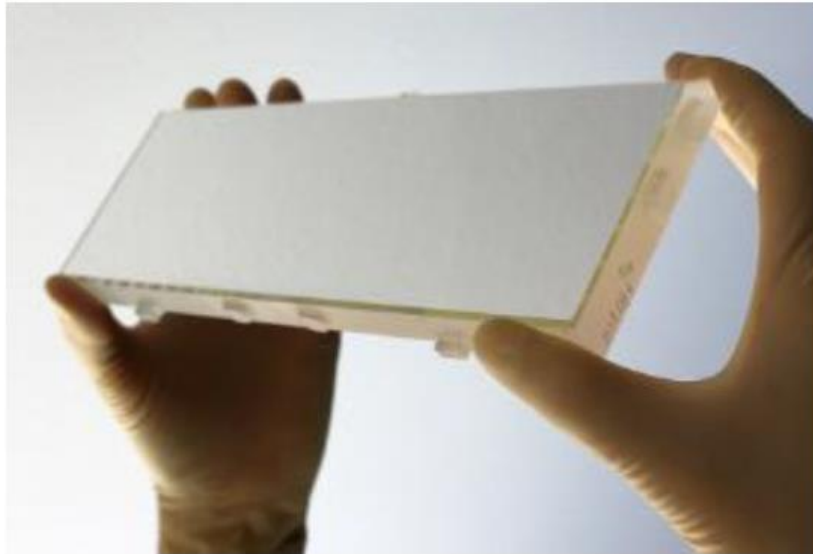


Types of Space Coatings

Large Filters and Dichroic Plates



- IAD coated Beam Splitter Assembly: dichroic and compensator plate
- Dichroic/compensator sizes: 288 x 96 mm
- $T_{\text{SWIR}} > 90\%$ / $R_{\text{VNIR}} > 98\%$
- Polarization $< 1\%$ / 2% (VNIR / SWIR)



courtesy of 

Large Optics Capability

➤ Large Filters:

- Coating uniformity:
 - < .5 % over 700 mm (3-4nm)
 - < 0.25 % over 600 mm (~2nm)
- Physical substrate size: **750 mm**

➤ DBS and High-Performance AR coatings:

- Coating uniformity: < 1.5% over 950 mm (< 15 nm at one micron)
- Physical substrate size: **1,000 mm**

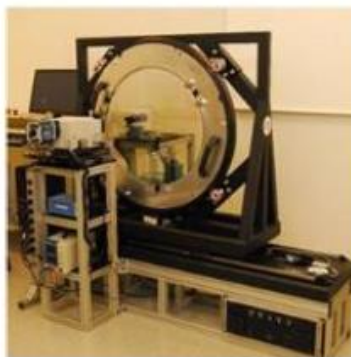
➤ Enhanced Mirrors

- Coating uniformity: < 4% over 1250 mm (< 60 nm, NIR)
- Physical substrate size: **1,400 mm**



Materion's state-of-the-art Large Optics Coating Facility in Westford, MA has been online since 2012. The centerpiece is our large vacuum coating chamber which can coat optics up to 1.4 meters (55 inch) in diameter. While other firms may be able to coat optics this size and larger, we add greater value by producing highly complex coatings with exquisitely good uniformity over a large area. Essentially, we scale the same process used for an eight-inch part to produce similar quality results for larger optics. This allows us to meet our astronomical community customer's requirements for larger-sized optics and support very high-performance space programs, worldwide observatories and space hardware contractors.

For information on Materion's large optics coating capabilities, please contact: David [Harrison@Materion.com](mailto:David.Harrison@Materion.com)



- ✓ 1.4 METER SIZE
- ✓ Low temperature
- ✓ Precision mechanical stress control
- ✓ Low Absorption & Scatter
- ✓ High reflectance



Summary

- ✓ MBO Space center (Westford and Jena) can offer the various range of optical components needed for the EO market
- ✓ Monolithic arrays allow lithographic accuracy and smallest feature sizes
- ✓ Butcher block arrays show high flexibility in terms of geometry, spectral performance, and number of different bands
- ✓ For Grating configuration , we are offering OSF filters to eliminate the multi order diffraction
- ✓ Hybrid approach possible : ex : LVF + Pan Chromatic band
- ✓ Large Mirror Coating Capability up to 1.4m available for Sat-Com Mirror Volume need

Questions?

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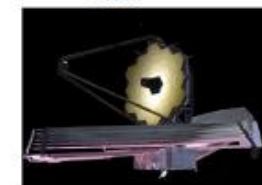
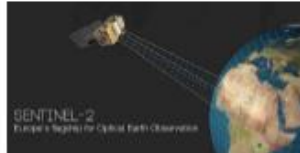
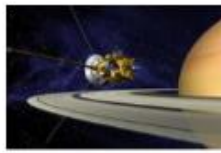
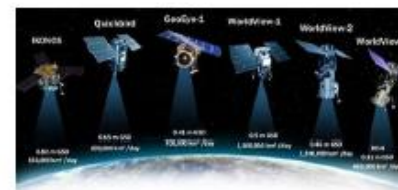


MBO Space Flight Heritage

- ✓ Spans over 40+ years
- ✓ Supports major National Space Agencies and Aerospace Primes
 - ✓ 100's of programs, 1000's of filters
 - ✓ Deep Space Exploration, Earth Imaging, Free Space Communication, LIDAR
- ✓ Bandpass and edge filters, dichroic beam splitters, enhanced mirrors, conductive coatings, LVFs, attenuators, occulting masks and a variety of custom coatings.



- ✓ Formats
 - ✓ Discreet elements
 - ✓ Assembled multi-spectral arrays
 - ✓ Patterned multispectral arrays
 - ✓ Mounted or unmounted



Hubble

NBRC - Bandpass & blocking filters (4um - 5.5um)
FGS - Bandpass & blocking filters (4 - 5.5um)

