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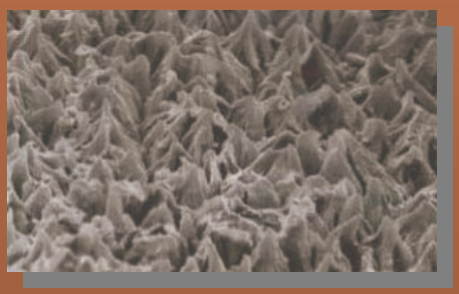
Science

DEEP SPACE BLACK

Stray Light Control For Optical Systems



N-Science Corporation - NEWWORLD Science & Instrumentation

Partners in Innovation/Technology/Production for DEEP SPACE BLACKs

A DARKER SHADE OF BLACK

Product Description

DEEP SPACE BLACK™ is extremely absorptive over a wide range of wavelengths from ultraviolet (UV), throughout the visible, and into the infrared (IR). The combination of surface absorptivity and mechanical stability of the material over this range provides its unparalleled performance.

DEEP SPACE BLACK™ is produced by N-Science/Advanced Surface Technologies in Arvada, Colorado.

Deep Space Black™ Family of Products

DEEP SPACE BLACK - VIS™: DSB-VIS is optimized for performance in the visible wavelength regime.

DEEP SPACE BLACK - Full Spectrum Basic™: DSB-FSB is optimized to provide best performance over the largest wavelength regime possible.

DEEP SPACE BLACK - Full Spectrum Enhanced™: DSB-FSE is a special variant of DSB-FSB that has a more robust finish with the same outstanding optical characteristics of the FSB. This product is more suited to spacecraft applications, including those applications concerned with LEO environments
Samples are available by request!

Applications

Reduce Stray Light and Improve Image Quality in Optical Systesm
Detector Calibration Sources/Blackbody Cavities
Thermal Control & Radiator Surfaces
Telescopes & Scanner Assemblies
Improved Contrast and Acuity for Visuals/Vision Systems
Spectrometers
Fiber Optics
Detector Coldshields
Optical Detector Assemblies & Housings,
Visual Display
Spacecraft Applications
Star Trackers/Star Cameras
& MORE

N-Science Corp, N-Sci/AST Optical Surfaces, 6155 West 54th Ave, Arvada CO, 80002
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Application Guidelines

- **Substrate Material: DSB** works best on aluminum substrates. 6061 preferred
- **Part Geometry:** With the proper attention to tooling design and usage, **DSB** fits most any geometry or part profile
- **Part Size:** There is no theoretical limit to size of part treated! [However a practical limit exists in the size of the processing equipment used!]
- **Part Design:** There are physical handling considerations that must be addressed for assembly, tooling, and packaging design
- **Parts Handling: DSB** surfaces should not be contacted by foreign surfaces to assure best performance and this should be designed into the part design and assembly lay-out
- **Part Masking and Combined Coatings:** N-Science/AST has masking materials available allowing **DSB** to be applied to selective surface features! This extends the capability to utilize **DSB** in combination with other treatments (e.g., black anodize). A typical example of this approach is a lens barrel assembly with an interior wall treated to **DSB** standards and outside surfaces done in hard black anodize

Space Qualification

DEEP SPACE BLACK - Full Spectrum Basic™ (DSB-FSB) has undergone Space Qualification Testing at Sandia National Labs.

The full Space Qualification Test Report is available on our web-site at www.nscicorp.com

Test Type	Sample Size, # Failures allowed	Acceptance or Inspection Criteria	Test Result	Qualification Status
Dimensional Change	Sample Size = 3 No Failures	Shall not increase by more than 50 µm.	Average thickness change = 13.4 microns, sigma = 33.52 microns	PASS
Particulate Generation	Sample Size = 1 No Failures	No evidence of particulate after vibration.	No evidence of particulate after vibration	PASS
Local Thermal Stress	Sample Size = 1 No Failures	No visually observable change in uniformity.	Visible change in color, determined not to be of significant impact	PASS
Outgassing, NASA CTVS	Sample Size = 1 No Failures	Total Mass Loss ≤ 1.0%, Volatile Condensable Material ≤ 0.1% (water vapor subtracted).	TML 0.23 %, WVR corrected TML 0.08%	PASS
Outgassing, Residual Analysis	Sample Size = 1	Informational test only.	No outgassing components identified.	PASS
Optical Properties (Pre- and Post-Thermal Vacuum)	Sample Size = 3 (1 Sample Post TV) No Failures	Total hemispherical reflectance ≤ 0.25% (0.25 to 1.10 µm).	Hemispherical Reflectance < 0.02%	PASS

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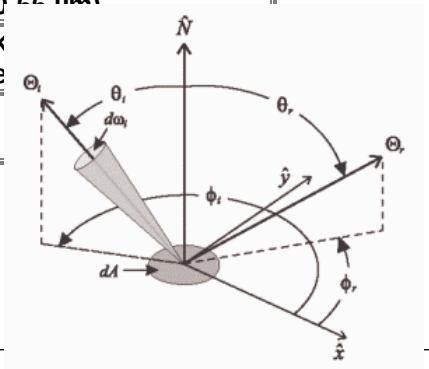
PRODUCT CHARACTERISTICS

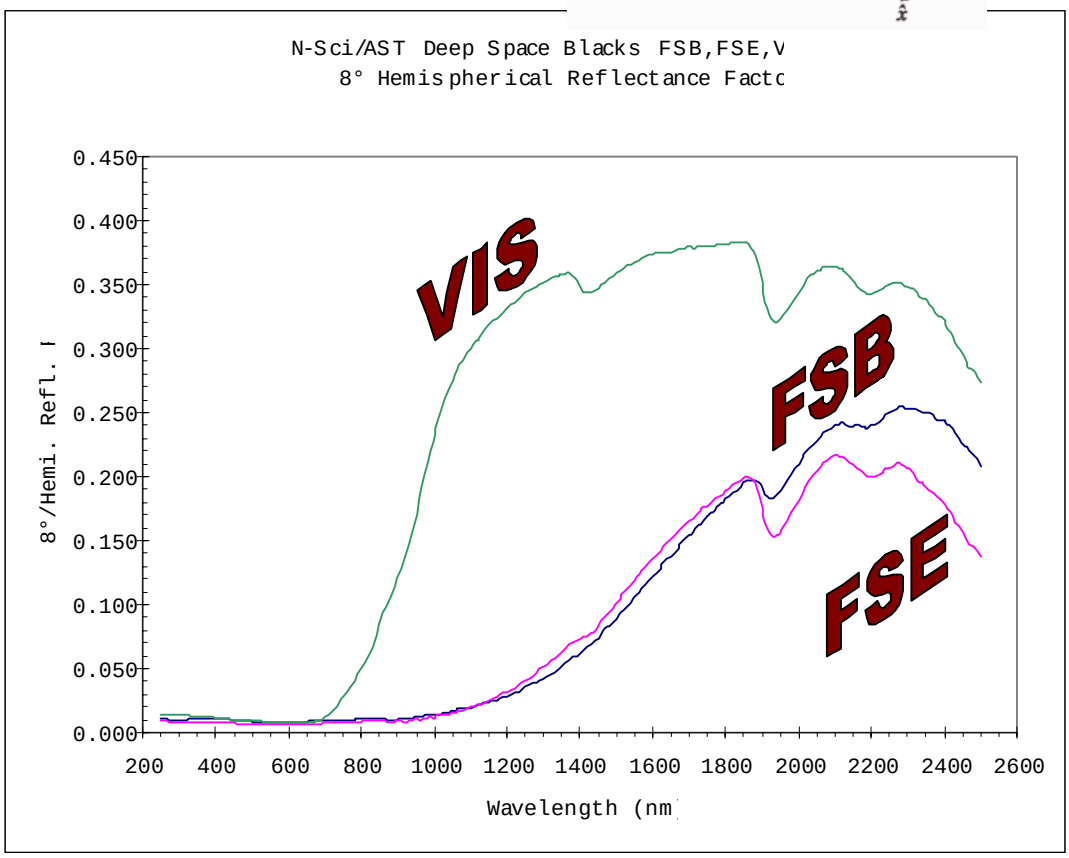
Deep Space Black Characteristics (note: DSB-FSB)

Parameter	Value
Total Hemispherical Reflectance (THR)	0.78% (0.4-1.0 µm)
THR, Visible Spectrum	0.37% (0.4-0.7 µm)
Thermal Emissivity	0.988 (10.66 µm)
Thermal/Vacuum Performance	Survival Range 77°K not Measurable
Reflectance Peaks	at 2.3 micrometers at 5.8 micrometers



Deep Space Black Family Portrait

Performance Comparison



Cost Comparison

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The DSB cost variations map directly with the performance and complexity involved with the given process. DSB-VIS is the least complex process and is our least expensive surface. At the other end of the spectrum, DSB-FSE is our best performer "overall" (particularly from about 1850 nm on out) and by far the most complex of our processes and is our most expensive variant. Tooling and Masking do affect cost of course. Tooling cost is typically directly impacted by the geometry of the part; simple geometries are typically less costly than complex ones. Masking can be labor intensive and the cost relate directly to the complexity and/or precision of the masking required.

PRODUCT PROPERTIES

Electrostatic Charge – Deep Space Black surface does not support electrical potential higher than approximately 200 volts. Above this level, the charge leaks off through the coating with no change to the surface properties. This is typical of anodized surfaces of this type.

Vibration – The Deep Space Black surface could release some particles in "extreme" vibration environments. This is typical of anodized surfaces of this type and these extreme environments are typically harsher than the typical launch vehicle spectrums. The particles in this case can be removed from the surface by a cleaning process. Test results indicate that the cleaning process eliminates particles to the background level of particles collected at random with a sample tape. The DSB Surface has been exposed to Vibration Testing. See the Sandia National Labs Space Qualification Test Report and Matrix. There was no mechanical or optical deterioration.

Temperature and Vacuum – The Deep Space Black surface will show no deterioration or degradation after exposure to the following environments:
Temperatures up to 450 deg C at 10 to the minus 5 Torr
Simulated sunlight (including ultraviolet) exposure for 500 hours at 10 to the minus 5 torr
See Also the Sandia National Labs Space Qualification Test Report

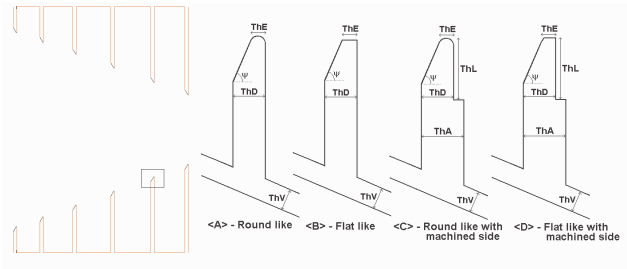
Cryogenic Test - Hemispherical emittance (absorbance) tests were conducted at 4 and 77 K. In the far-infrared region (7 to 120 • m), emittance was 0.985 or better.

Handling – Abrasion by touching, wiping, or dropping articles on the surface modifies the surface structure and may reduce the absorptivity or Lambertian character of the surface. The surface is also subject to contamination from dust, airborne particles, and outgassed organic molecules or clusters, and this contamination will change the optical properties of the surface. It is important, therefore, to handle parts with Deep Space Black surfaces with the care afforded "all" optical surfaces.

Outgassing – Deep Space Black passes NASA SP-R-0022A specifications (*General Specification, Vacuum Stability Requirements of Polymeric Material for Spacecraft Applications,* 9 September 74). It is found that most anodize surfaces of this type do well in testing for this

characteristic. Early studies from the literature on the outgassing of black surfaces are available. Oak Ridge National Laboratory (C.M. Egert and J.A. Basford: "Vacuum Outgassing from Diffuse-Absorptive Baffle Materials." Proceedings of the SPIE, Vol 1330, 1990, pp 178-185) and Goddard Space Flight Center (T. Heslin, and R. Hunkeler: "Outgassing Rates of Various Aluminum Anodizes." *Materials Technology Report*, MTR No. 755-011, Goddard Space Flight Center. April 1975). Studies indicate that water is the primary component, followed by two other elements of air – nitrogen and oxygen. Between 240 C and 800 C carbon dioxide, sulfur dioxide, sulfur monoxide, and two unidentified species (34 and 78 atomic mass units) had been detected. See also the Deep Space Black Space Qualification Test Report by Sandia National Labs.

Baffle Edge Application – In the optical design of most sunshades, baffles are used to prevent stray light reflected by the interior surfaces of the shade from reaching the optical system entrance pupil directly. However, it is impossible to eliminate all light reflected by the edges of the baffles themselves; thus these edges must be designed to reflect the minimum light possible. N-Science works with your design team to optimize the baffle engineering approach.



Deep Space Black/Full Spectrum Enhanced – DSB-FSE provides a somewhat improved optical performance in the near- and middle- IR. Reflectances from about 37% at 2,3 µm to about 25% and from about 15% at 5.5 µm to about 3.5% has been demonstrated and verified in characterizations by our customers. The performance in the visible region of the spectrum is maintained. From historical information, we know that the so-called "enhanced" versions of similar surfaces have shown themselves to be somewhat more robust in fighting the Atomic Oxygen degradations in Low Earth Orbit (LEO). These similar surfaces were subjected to atomic oxygen testing. The results were documented in the Proceedings of the SPIE, Vol 511, 1984, pp 24-30.

Process & Material Specifications For Deep Space Black

Deep Space Black – Visible (VIS)

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Process	NAOSG-20020P Rev A (January 1, 2005)
Material	NAOSG-20020M Rev A (January 1, 2005)
Equipment	NAOSG-20020E Rev A (January 1, 2005)

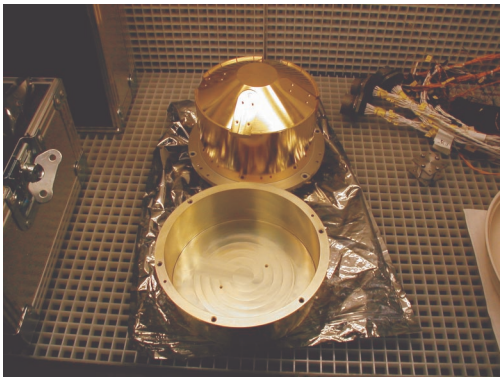
Deep Space Black – Full Spectrum Basic (FSB)

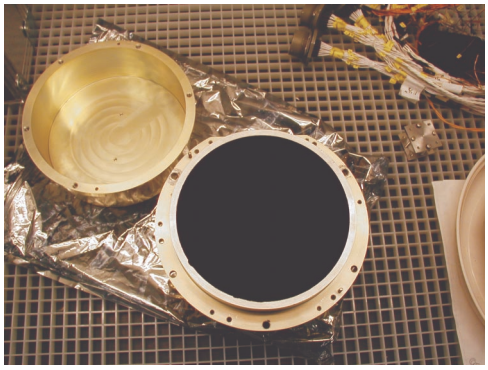
Process	NAOSG-20021P Rev A (January 1, 2005)
Material	NAOSG-20021M Rev A (January 1, 2005)
Equipment	NAOSG-20021E Rev A (January 1, 2005)

Deep Space Black – Full Spectrum Enhanced (FSE)

Process	NAOSG-20022P Rev A (January 1, 2005)
Material	NAOSG-20022M Rev A (January 1, 2005)
Equipment	NAOSG-20022E Rev A (January 1, 2005)

NOTE: Process Specs are N-Sci/AST proprietary

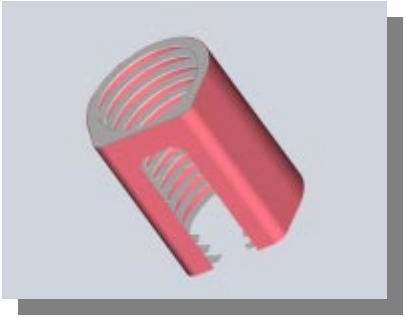




Application Example : Blackbody Cavity
DSB Interior surface with Gold External surface

New Application Concepts
Monolithic Baffle Approach

Application Example;
UKahlStar Star Tracker



GET THE DETAILS- ***www.nscicorp.com***

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