Heraeus Fused Silica Opaque Optical Diffuser Material: HOD500

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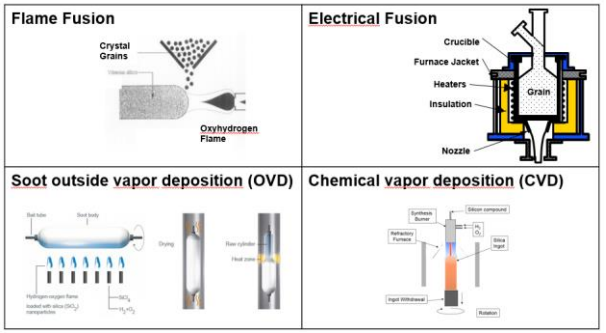
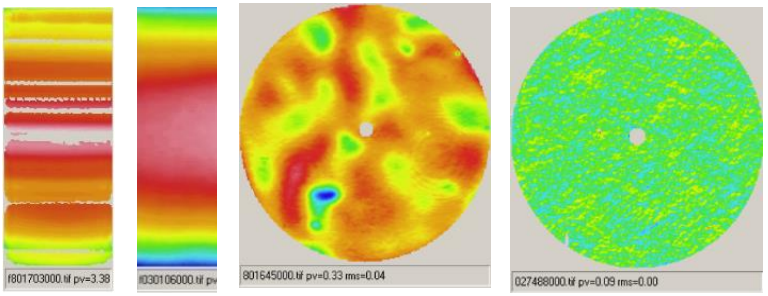
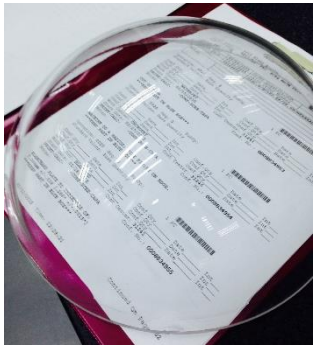
Heraeus Quarzglas - What sets us apart ?

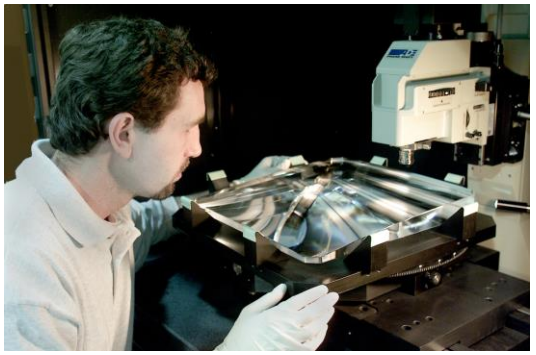
- More than 100 years of experience in quartz glass
- All 4 production processes in house
- Only material supplier with 3-D homogenisation process
- Precision molding
- R&D team for support and providing technical data



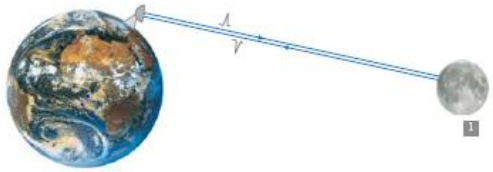




Custom Tailored Products

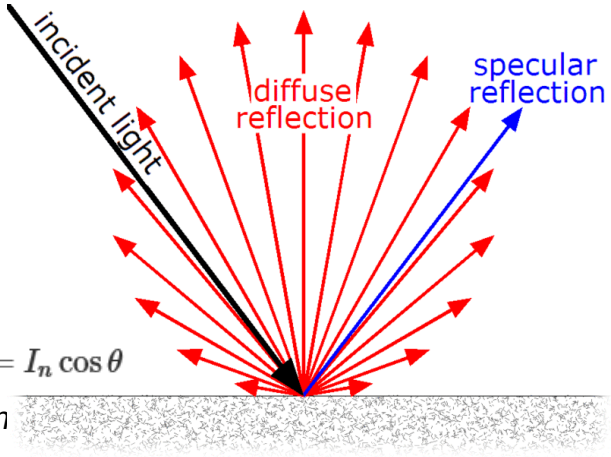


- Optics for Fusion lasers:
  - NIF, CEA, LLE Omega
- Quartz glass for Space Applications
  - Laser Ranging, Einstein Gravity Probe B, Vista
- Optics for Science
  - VIRGO & LIGO & GEO600
- Defense
  - Air Borne Laser
  - UAV / Directed Energy



Definition: Diffuser

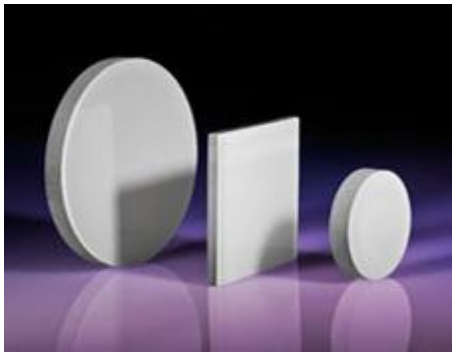
- Optical diffusers are used for uniform dispersion of light in a variety of industrial applications.
- In optics, a diffuser is any device that diffuses, spreads out or scatters light in some manner, to give soft light.
  - Light reflects and diffused from a white surface
  - translucent materials as compact optical diffusers
- Perfect diffuser:
  - Lambertian reflectance (its brightness appears the same from any angle of view)

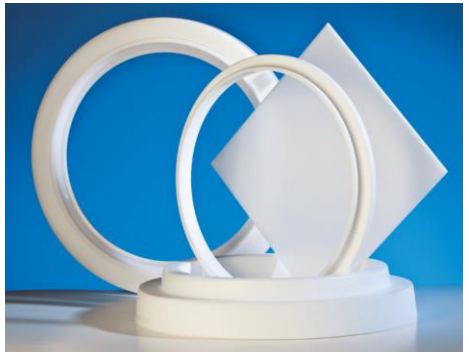


Fairchild, Mark D.: Color Appearance Models. John Wiley & Sons. p. 6
Juds, Scott M.: Photoelectric sensors and controls: selection and application

Current Products

- Ground or Chemically treated Glass
- Flashed Opal glass surfaces
- PTFE plastic (Polytetrafluoroethylene)
- OM-100 from Heraeus, designed for Semi-Conductor applications





Disadvantages

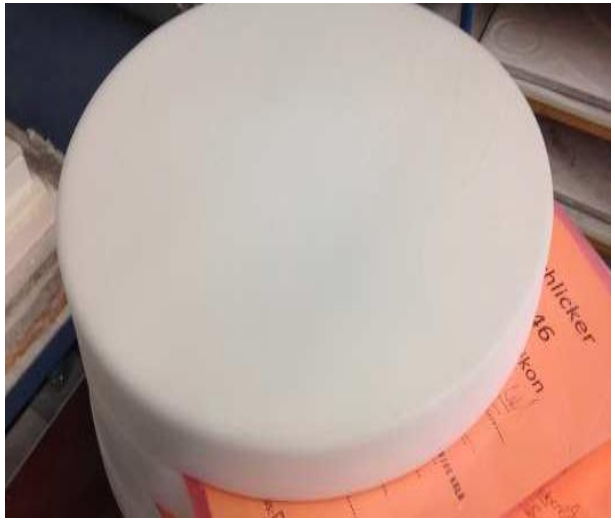
- **Ground, Chemically or Flashed Glass)**
  - Almost Lambertian diffuser
  - Depending on base material different working wavelength ranges
- **PTFE plastic (Polytetrafluoroethylene)**
  - for >400 °C loss of stability
  - Change of reflection behavior over time → recalibration
    - Reflectivity loss below 250nm
    - Potential UV degradation
    - Low density of 1.25 – 1.5 g/cm3 leads to bad mechanical stability
  - porous properties
- **Opaque natural quartz, e.g. OM-100 from Heraeus**
  - Improvement for a lot of parameters, but still:
    - Marbel effect → no homogeneous density
    - Transmission and reflection loss in UV due to metallic impurities

HOD Motivation

- Product improvement over OM-100
- Maximum reflectivity/transmission from UV, VIS to NIR
- Longterm stable behavior
- Machineable
- Homogenious density distribution
- Low level of metallic impurities
- Low fluorescence
- Lambertian behavior

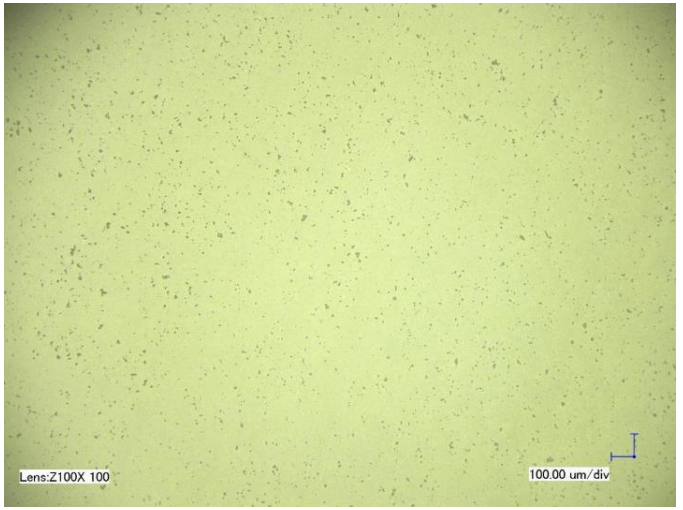
About HOD

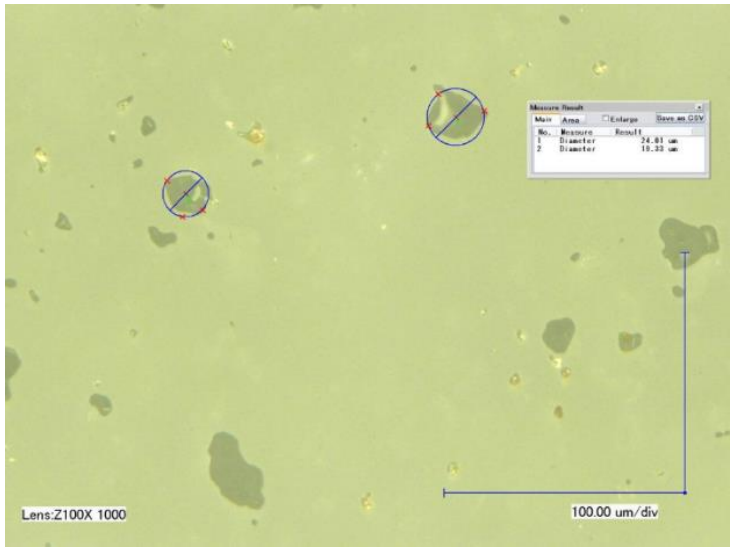
- Heraeus Optical Diffusers are uniform opaque (white) sintered fused silica and fused quartz materials molded into shape
- The material is produced by molding & high-temperature sintering of high purity fused silica or fused quartz powder into a bulk material with uniform micro-bubbles. The starting powders and controlled bubble content produce the desired optical characteristics
- This results in bulk material & components that produce the optimized performance
- Currently Heraeus Optical Diffuser materials & components are available in two grades
  - HOD -300: fused quartz
  - HOD-500 : fused silica (enhanced UV, purity)



Heraeus Optical Diffuser – HOD-500

- Base material: fused silica
- Scattering centers: bubbles Ø<25µm
  - Keyence light microscopy,
    100x and 1000x magnification

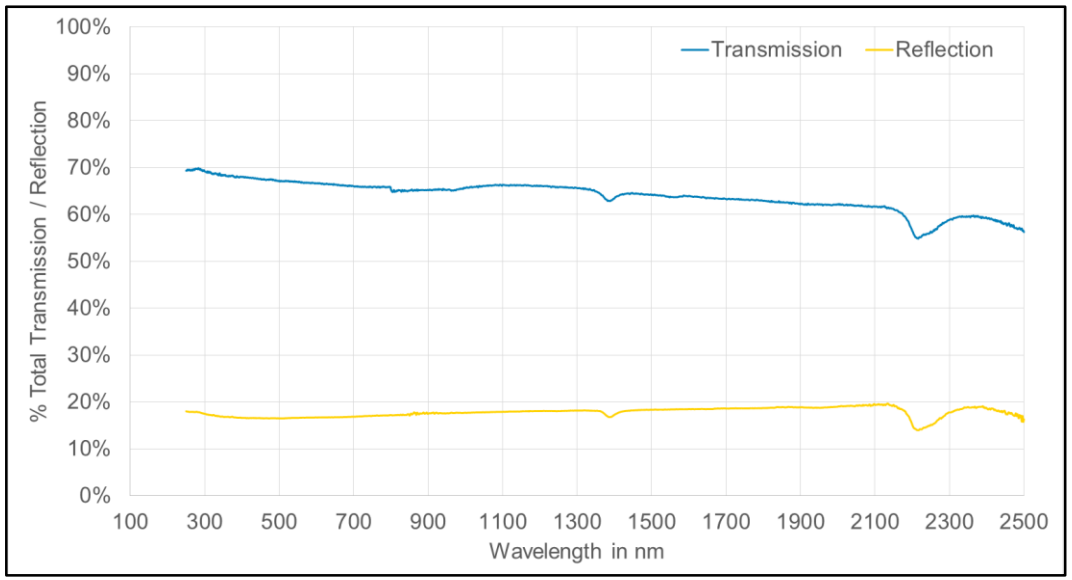




Can be used in **reflective** and **transmissive** mode
→ performance depends on thickness

Heraeus Optical Diffuser – HOD-500

- Density: 2.155 g/cm^3 ± 0,25%
- Typical metallic impurities: < 0,36 ppm
- OH content: ~455 ppm ± 5%
- Typical transmission / reflection for a 5mm thick fire polished diffuser*:



*depends on thickness, surface finish and measurement setup

Element	Typical metallic impurities in ppb
Li	<10
Na	34
K	24
Mg	15
Ca	120
Fe	29
Cu	<8
Cr	<8
Mn	<8
Ti	<10
Al	50
Zr	<10
Ni	<8
Mo	<10
W	<10
C	<10

Applications

- Radiation hard regime
  - Diffuser in space bound spectroscopy, e.g. satellites for solar or atmospheric measurement/analysis
- Diffuser application in IR and UV
  - Spectroscopy
- Laser Calibration standards
  - Spectroscopy
- Uniform radiation cavity
  - Laser cavities
  - Integrating sphere
- Attenuator / filter
  - Beam dump

Summary

- Heraeus Optical Diffuser HOD-500
- Customer tailored diffuser product initially developed for space applications
- opaque fused silica
  - Small enclosed air bubbles
  - Maximum reflectivity/transmissivity from UV to NIR
  - Closed porous
  - Strong and machinable
  - Long term stablility
  - Homogenious density
  - Low metallic impurities and low fluorescence
  - Lambertian behaviour
- A product for more than just space !!!!