

HORIBA
Scientific

200 YEARS
1819-2019
HORIBA JOBIN YVON

Sharing light and passion

200 years of optical innovation

1819 - 2019

www.horiba.com/en_en/200years

EPIC Online Technology Meeting
on Earth Observation

HORIBA's Gratings technologies for space and Earth Observation

William Renard, PhD
Sales Engineer, Custom gratings

2022/11/28

From HORIBA to optical gratings...

HORIBA
Scientific



Automotive Test Systems



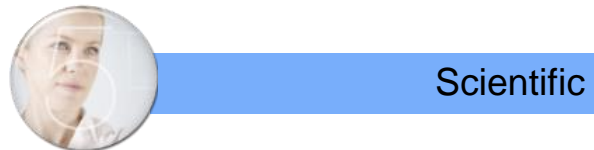
Process & Environmental



Medical



Semiconductor



Scientific

- Analytical instrumentation (Molecular spectroscopy, emission spectroscopy, particle size analyzers,...)
- OEM systems (Spectrometers, Monochromators, HSI cameras), OEM gratings and Custom gratings

Custom Gratings:

- VUV/Synchrotron applications (high-quality, full customization)
- High-Energy Lasers applications (largest gratings manufactured for PW Lasers)
- Space/Astronomy applications (> 40 years & > 50 missions this field)
- Cross-gratings for metrology

Custom gratings are designed and manufactured at:
HORIBA France: a Center of Excellence
Initially Jobin Yvon

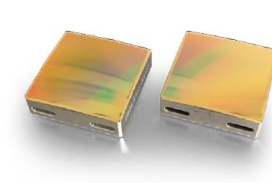
Created in 1819 from the collaboration between
Augustin Fresnel and Jean-Baptiste Soleil

200 years of optical innovation

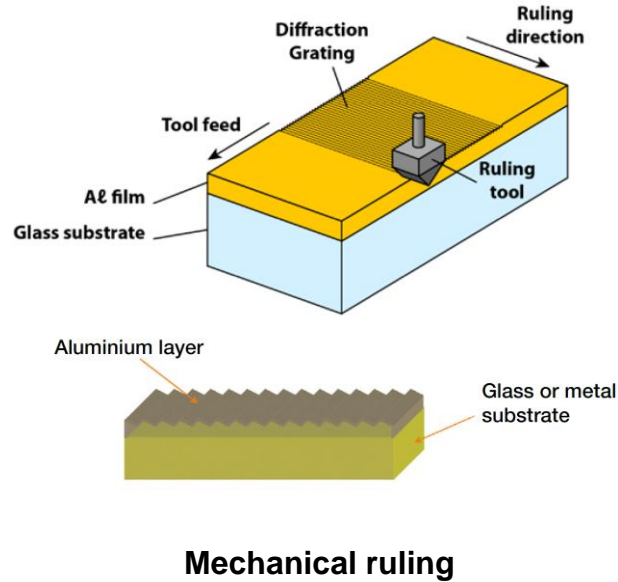
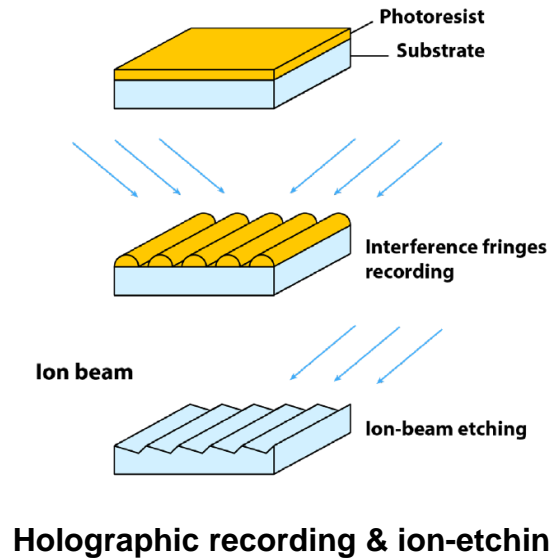


European Research at Paris Saclay

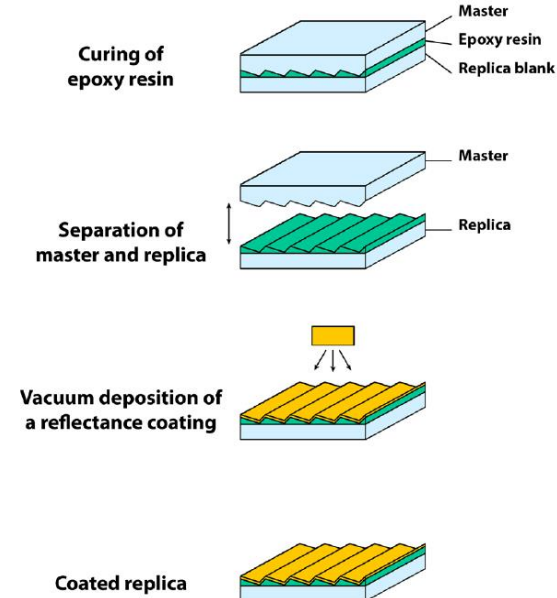
HORIBA's Gratings Technologies



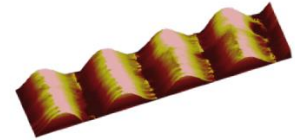
Masters



Replicas



Sinusoidal



Triangular (sawtooth)



Lamellar



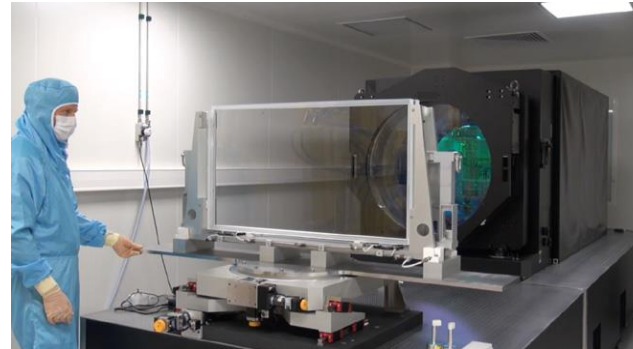
Substrate shape	Substrate material	Aberration correction	Groove density	Metallic coating	Spectral range
Plane, spherical, toroidal, freeform, prisms	Silica, Zerodur®, SiC, Aluminum	Type IV or Variable Line Spaced	From 30 l/mm to 4800 l/mm	Gold, Aluminum, AlMgF2, Platinum, Nickel	From deep UV to MIR

FULL CUSTOMIZATION POSSIBLE THANKS TO COMPUTATION TOOLS
Grating efficiency calculations, Zemax optimization

HORIBA's Gratings Metrology tests & qualifications

Typical Metrology tests for space projects

- **Grating profile characterization**
→ *Atomic Force Microscope*
- **Substrate/grating surface/wavefront error**
→ *Interferometer*
- **Efficiency** (relative or absolute / Mirror with same coating)
→ *Efficiency-meter*
- **Groove density & orientation measurement**
→ *Goniometer*
- **Stray light**
→ *Computations & BRDF/BTDF*
- **Substrate Microroughness**
→ *Microscope*
- **Visual inspection:**



Quality & Qualifications

- ISO 9001/14001 company
- Qualification plan according to ECSS standards
- Long Duration Exposure Facility (LDEF) mission heritage
- Heritage from past missions

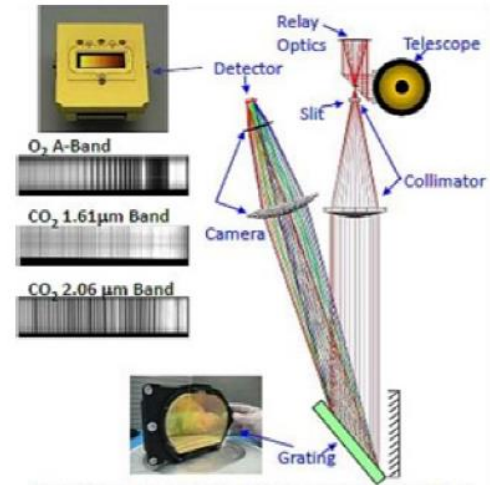


HORIBA's Gratings Application examples (1/2)

- **Plane or spherical gratings with aberration correction:**

- Holographic recording with high groove density,
- Aberration correction recorded with the grating,
- Work at 1st order, ion-etching possible,
- Good performances vs. Stray-light

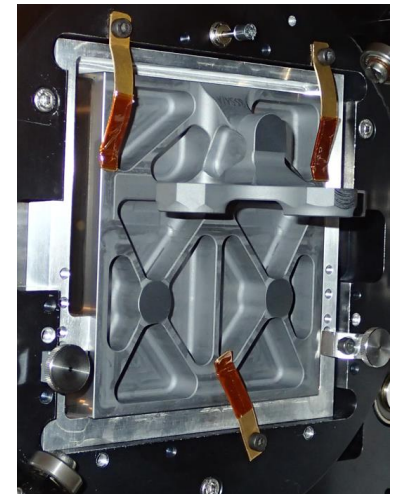
→ Example **OCO/OCO-2** mission (NASA)
for CO₂ monitoring on Earth



- **Plane Ruled Echelle gratings:**

- Mechanical ruling, high blaze angles (triangular shape)
- Low groove density, high efficiency in different working orders → Compact instrument design!

→ Example **MicroCarb** mission (CNES)
Echelle replica gratings on SiC substrate,
Efficiency > 50% on 4 spectral bands: 758-769nm – k40,
1264-1283nm – k24, 1596-1620 – k19 and 2022-2053 – k15.



HORIBA's Gratings Application examples (2/2)



- **Gratings on prisms (GRISMS): Missions Sentinel-5 & CO2M**

- **Grating to be manufactured:**

Grism = Grating recorded on the exit surface of a prism; entrance surface is AR coated.
The grism works in transmission.

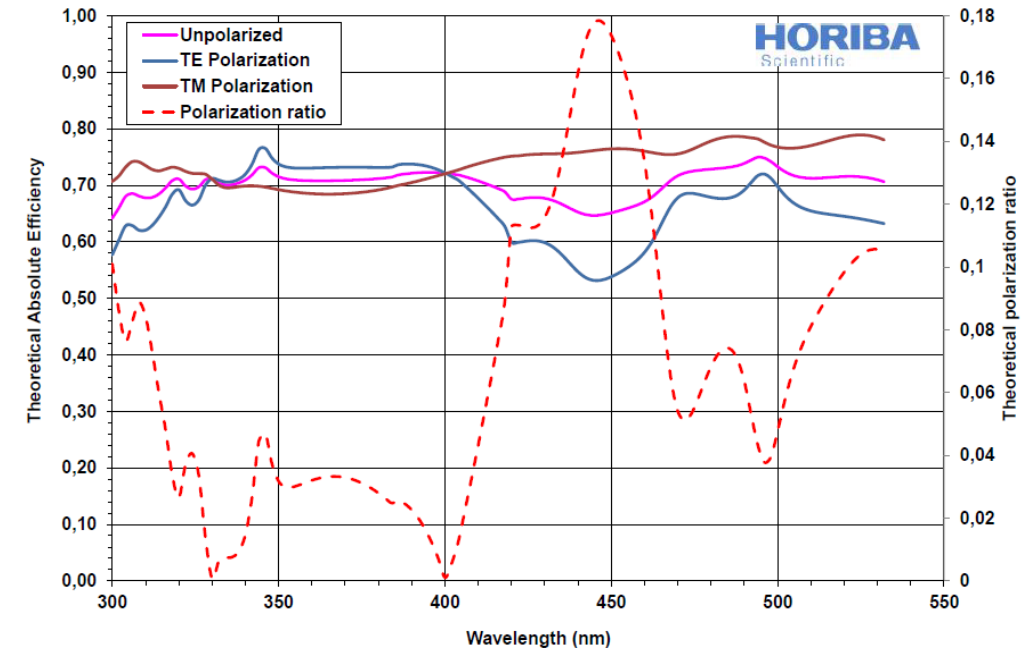


- **Challenges:**

→ High efficiency (> 55%) and low polarization ratio (< 15 %)
→ Holographic recording & ion-etching

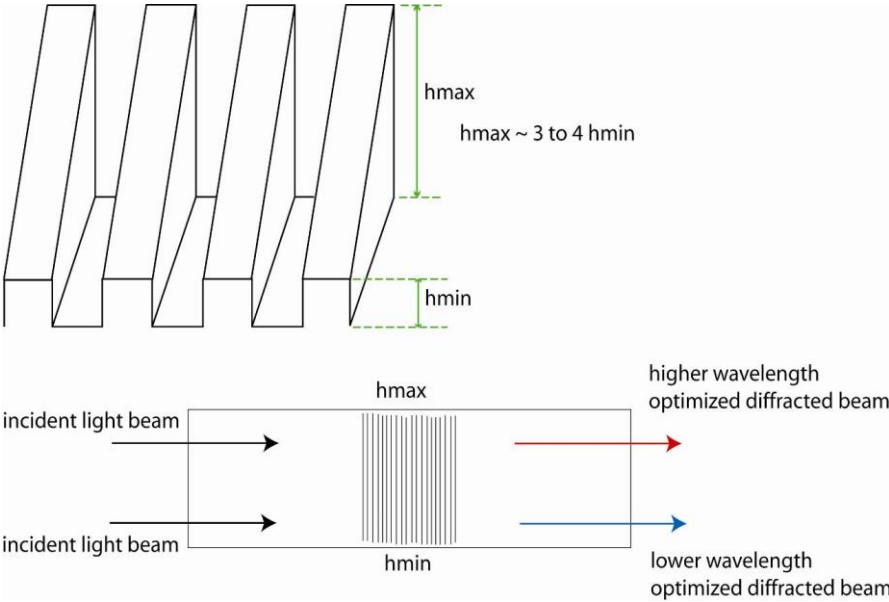
- **Grating parameters overview**

→ Spectral range : UV (300-500nm)
→ Groove density : 1499,25 gr/mm (+/-0,45)
→ Dimensions : 54x47mm
(grating clear aperture of 40,2x36,7mm²)



HORIBA's Gratings Variable groove depth

- VGD = Variable Groove Depth



VARIABLE GROOVE DEPTH GRATING
The Tunable blaze grating

- Continuously Variable Groove Depth (VGD) grating
- Holographic Ion-Etched diffraction grating
- VLS or constant groove distribution
- One grating to replace several ones

Omoshiro-okashiku
Joy and Fun



Terima kasih
谢谢
Gracias
Σας ευχαριστώ πάρα πολύ
धन्यवाद
شُكْرًا
Danke
Tack ska du ha
Grazie
THANK YOU
Obrigado
Большое спасибо
Cảm ơn
Merci
감사합니다
ขอบคุณครับ
ありがとうございました
Dziękuję