Current Status of Novel Gratings for Next Generation Astronomical Instruments VIII

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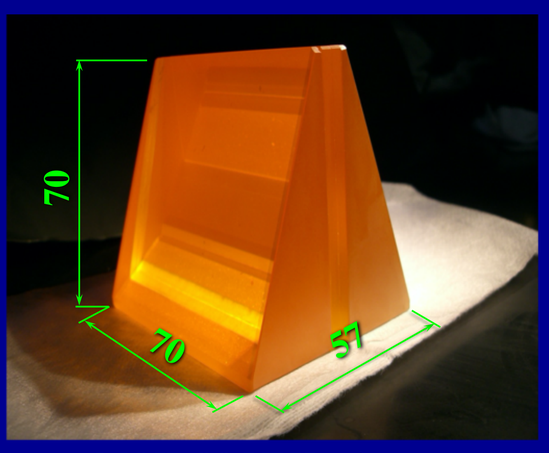
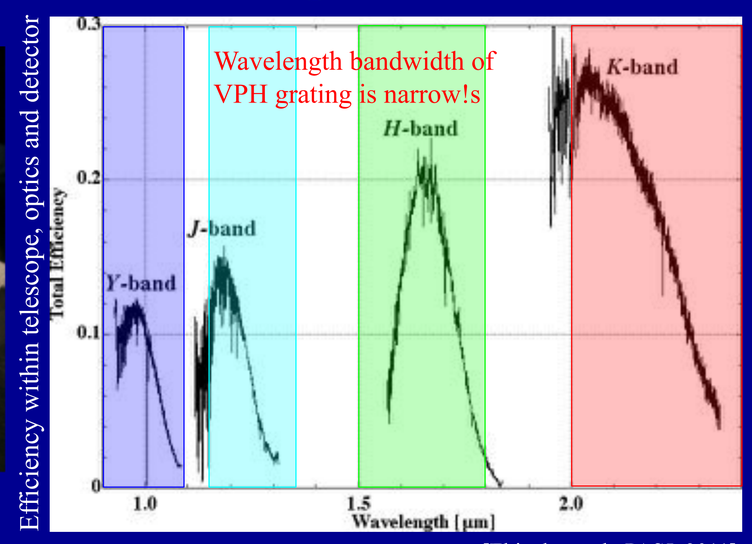
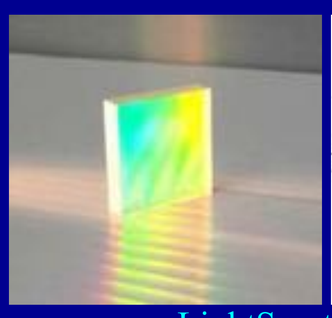
LightSmyth transmission grating for MOIRCS J- and H-band grism



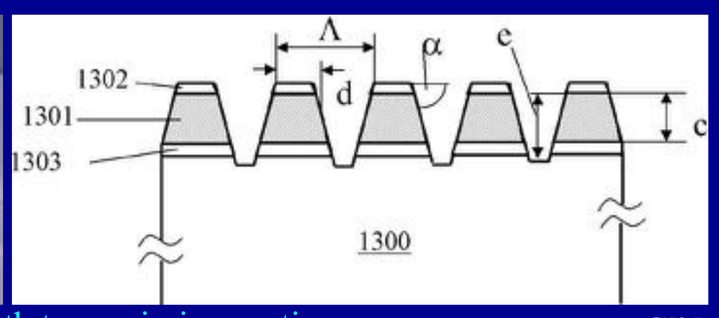
MOIRCS VPH grisms.



[Ebizuka et al., PASJ, 2011]

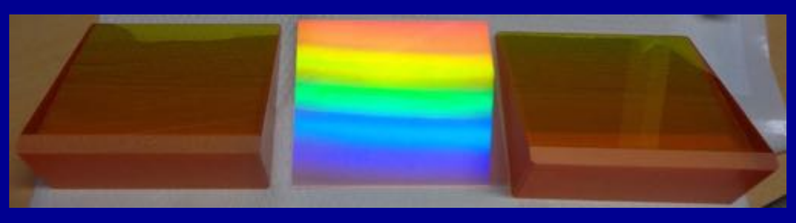


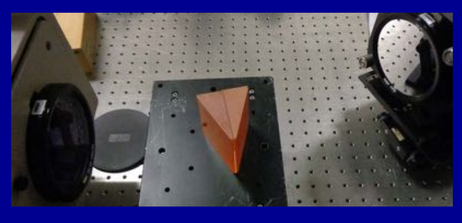
LightSmyth transmission grating

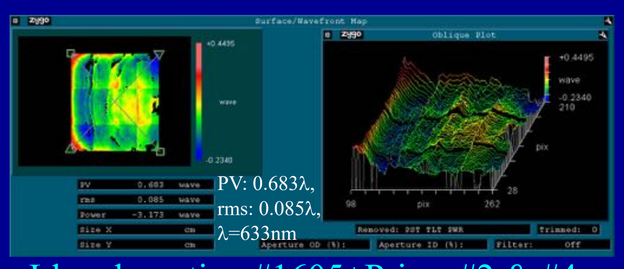


1302: SiO_2
1301: Si_3N_4
1303: SiO_xN_y
1300: SiO_2

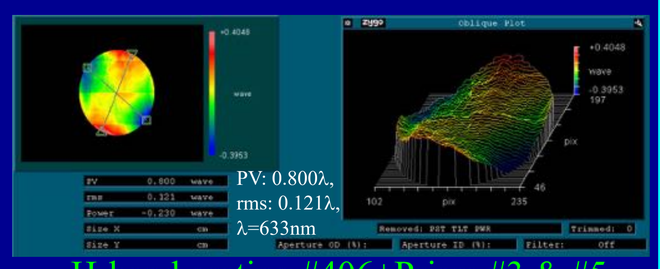
[US Patent: US 8,165,436 B2]



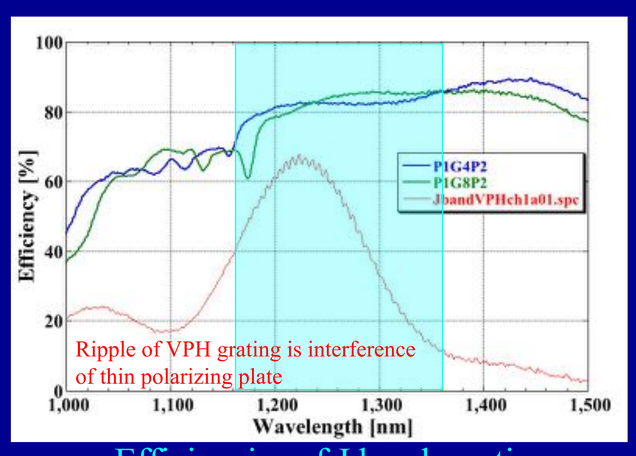




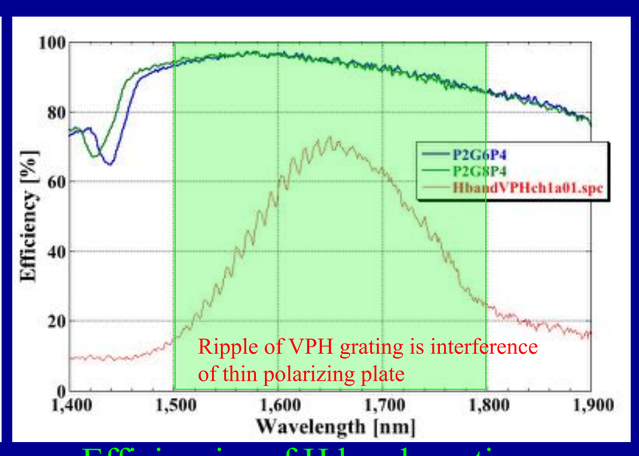
J-band grating #1605+Prism #2 & #4



H-band grating #406+Prism #3 & #5

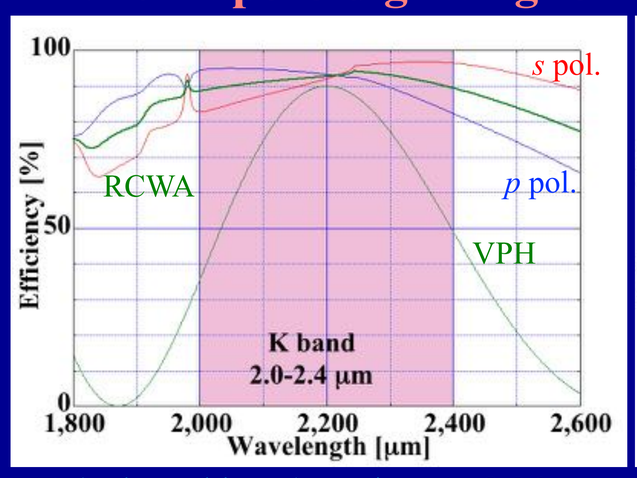


Efficiencies of J band grating

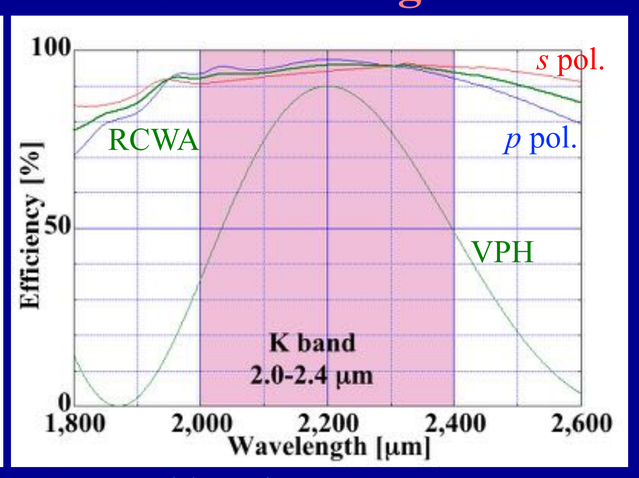


Efficiencies of H band grating

VB/Trapezoid grating for MOIRCS K-band grism

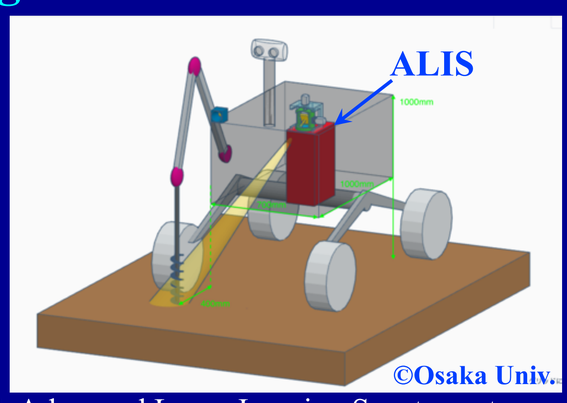


VB (volume binary) grating, Λ=2.36 μm, L&S=1:1, t=4.5 μm. Can be fabricated directly by plasma etching on quartz glass.

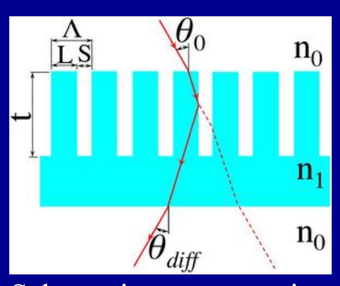


Trapezoid grating, Λ=2.36μm L&S=0.59:0.41, t=4.5 μm, Taper: 7.1°

Volume binary (VB) grating for ALIS of LUPEX

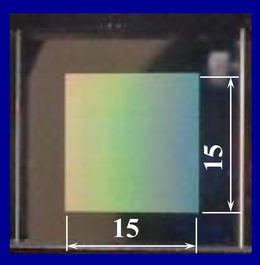


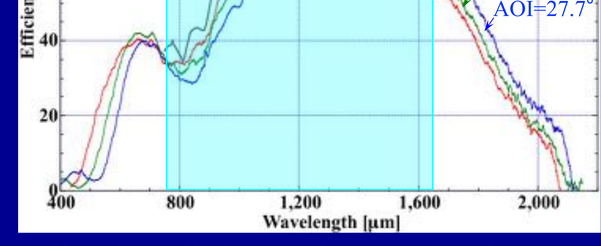
LUPEX: Lunar Polar Exploration Mission, ALIS: Advanced Lunar Imaging Spectrometer.



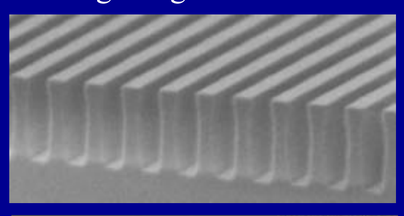
Schematic representation of VB grating.

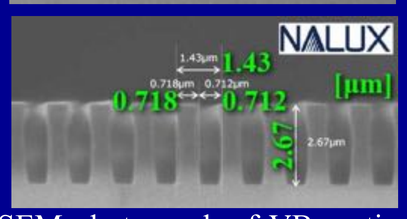
Λ=1.43 μm, t=2.65 μm, L&S=1:1, θ_0=24.8°, n_1=1.0, n_2=1.45.



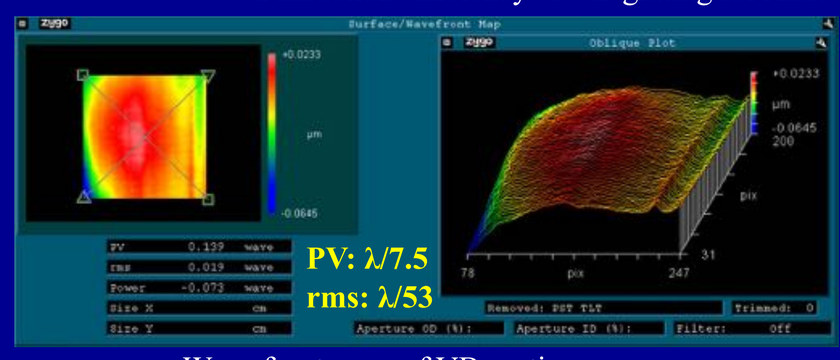


Diffraction efficiency of VB grating for ALIS.





SEM photograph of VB grating fabricated by anisotropic plasma etching on silica substrate.

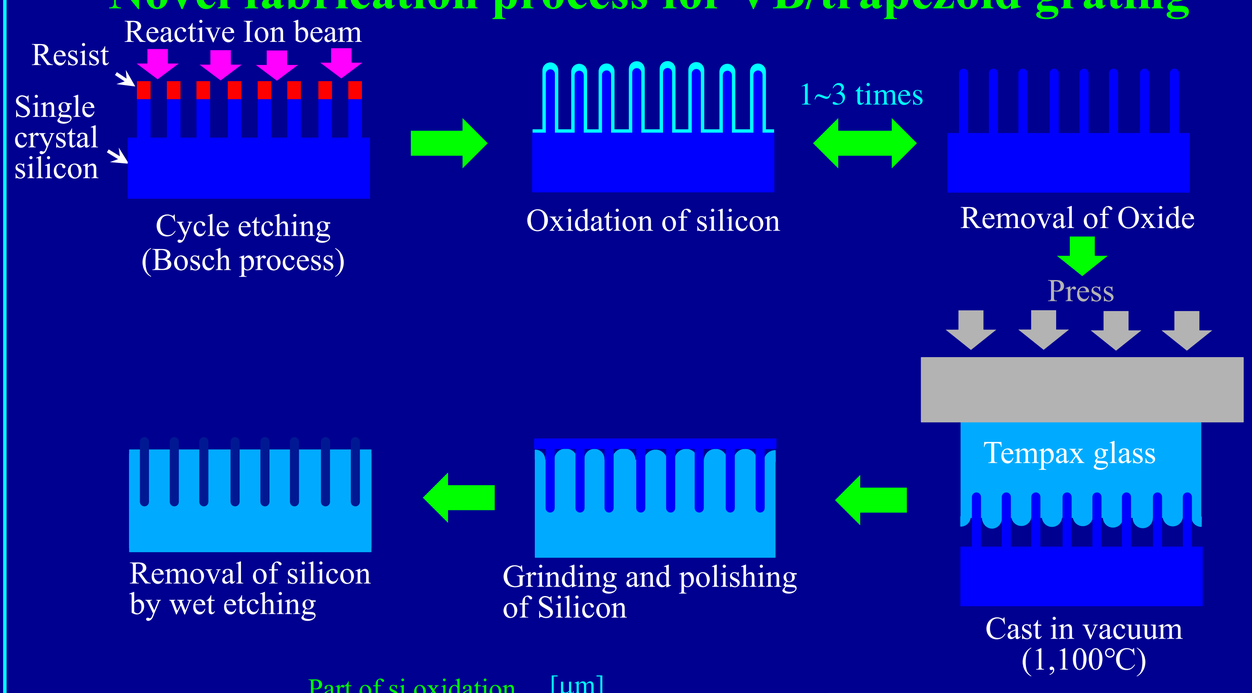


Wave front error of VB grating.

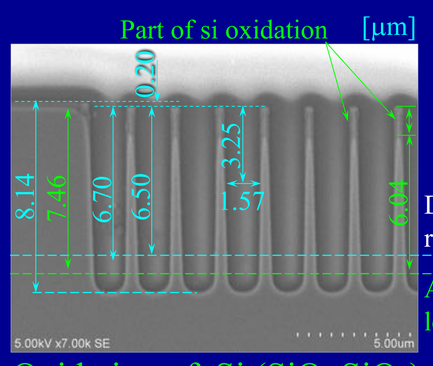
InGaAs detector for ALIS is changed!

Xenics (20×20 [μm], 640×512 pix) →Sony (5×5 [μm], 1280×1024 pix)
→Design and fabrication of lens became difficult.
Λ=1.43μm (700g/mm) →2.0μm (500g/mm)
→ A novel fabrication method for a VB grating with Tempax glass is developing.

Novel fabrication process for VB/trapezoid grating

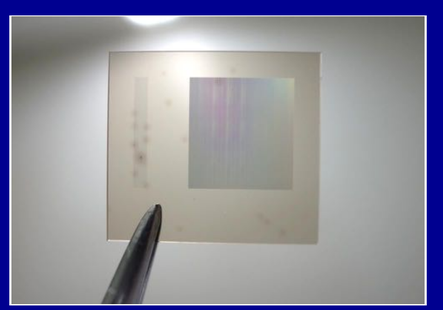


Λ=2.0 μm, t=6.5 μm, L&S=4:1, n_1=1.0, n_2=1.45.



Oxidation of Si (SiO, ~~SiO_2~~).

NALUX



Serious absorption appeared in Tempax glass.

Cast temperature: 1,100 → 1,000°C.

Summary

- Instead of VPH grisms of J and H-band for MOIRCS, we have developed grisms with LightSmyth transmission gratings.
- The VB and trapezoid gratings achieve very high efficiency and wide bandwidth of wavelength.
- Instead of the VPH grism of K-band for MOIRCS, we are developing a VB grism.
- We are also developing a novel fabrication method for a trapezoid grating of MOIRCS K-band grism by means of replication of a Si mold, as a prototype for TMT transmission gratings.
- A prototype VB grating with quartz glass for ALIS have fabricated.
- We are developing a novel fabrication method for a VB grating of ALIS with Tempax glass by using a Si mold. Cast temperature: 1,100 → 1,000°C.