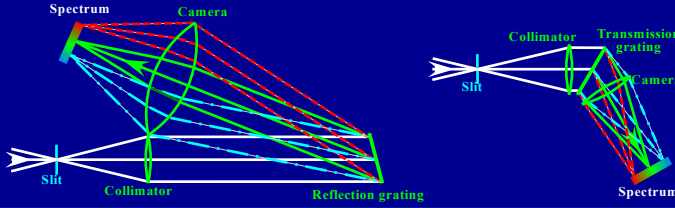


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Reflection and transmission grating

- Diameter of a camera lens exceeds maximum size (φ440) of calcium fluoride if a reflection grating is used as the disperser.
- Transmission grating can reduce size of the camera lens (→ total optical system).
- Transmission grating is able to realize perfect Littrow mounting.

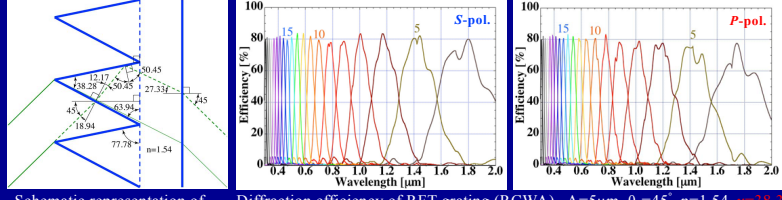


WFOS: Wide Field Optical Spectrograph

The first generation instrument for TMT. R = 500~5,000 (150~7,500 goal) @0.75" slit

Gratings for WFOS
Incident and diffraction angle: $\theta_0 = 36\text{--}53$
Period: $\Lambda = 2\text{--}5 \mu\text{m}$
Size: $400 \times 550\text{--}750 \text{ [mm]}$

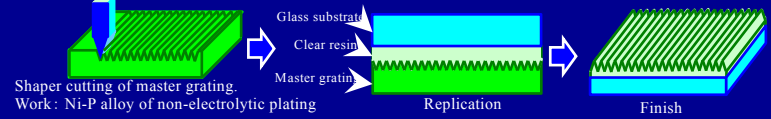
Reflector facet transmission (RFT) grating



Schematic representation of RFT grating. Diffraction efficiency of RFT grating (RCWA). $\Lambda=5\mu\text{m}$, $\theta_0=45^\circ$, $n=1.54$, $\gamma=38.3^\circ$.

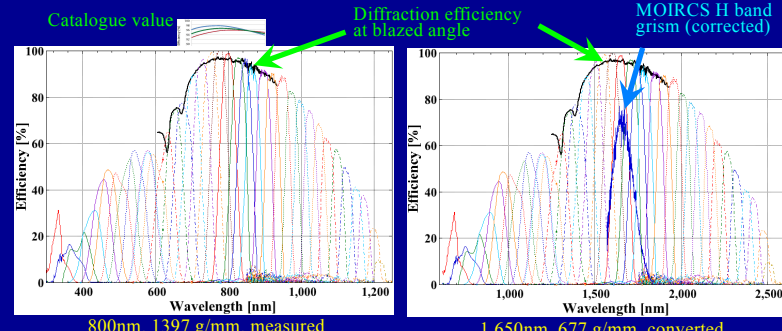
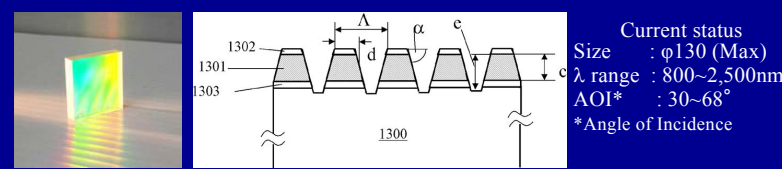
Shaper cutting of mold. First trial fabrication. Second trial fabrication. SEM photograph of master grating.

Fabrication method for RFT grating and for SR grating of MOIRCS hybrid grism



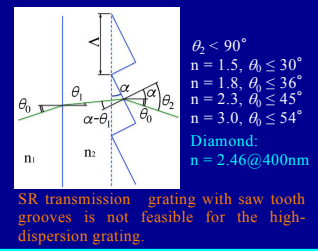
LightSmyth Transmission Grating

for MOIRCS J and H band grisms instead of VPH grisms



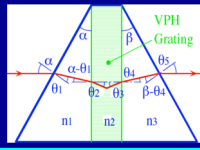
Measurement for diffraction efficiency at blazed angle. Measurement for peak efficiency of super blaze.

Limitation of surface relief (SR) transmission grating

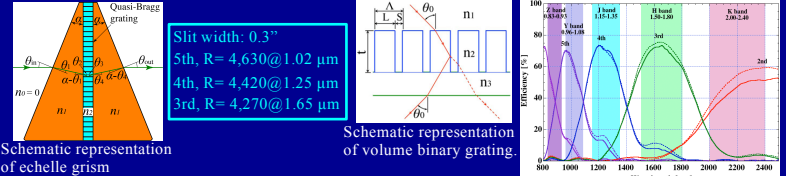


VPH grating

- VPH (Volume Phase Holographic) grating, in which refractive index is modulated sinusoidally achieves diffraction efficiency up to 100% for S or P polarization.
- VPH grating can not achieve high diffraction efficiency for natural and circular polarizations at high dispersion because characteristics of diffraction efficiencies are different between S and P polarizations.
- Birefringence VPH grating.
- Diffraction efficiencies of VPH grating decrease in higher orders.
- VPH grating is not feasible for an echelle grating.



Echelle grism (Volume binary grating) for MOIRCS



Fabrication process of the volume binary grating

Diffraction efficiency of volume binary grating (RCWA). L&S = 4.6:0.5 [μm], $\theta_0=28.4^\circ$, $n_1=1.33$, $n_2=1.6$, $n_3=1.6$, $t=16 \mu\text{m}$.

Silicon mold for replication test.

Volume binary grating of silicon. Fabricated by Nanotechnology platform of Toyota Institute of Technology.

Grism for MIMIZUKU

Fly cutting of Si grism. Microscope photograph of Si grism. Si grism: $a = 4.2$, $\Lambda = 17.09 \mu\text{m}$.

Fly cutting of Ge grism. SEM photograph of Ge grism. Ge grism $a = 3.41$, $\Lambda = 17.07 \mu\text{m}$.

Efficiency of prototype Si grism (including reflection loss). Transmission of Si and Ge (including reflection loss).

Summary

	Optimal Order	Eff. [%] (λ - λ μm)	Status of development
RFT grating	2th~	~ 80 (0.3~2.4)	Performed diamond shaper cutting of master gratings. Planning the third trial fabrication in this April.
Hybrid grism	2rd~	~ 70 (0.3~2.4)	Performed diamond shaper cutting of a master grating and replication. Planning fabrication of optimum master grating for MOIRCS medium dispersion grism in this March.
LightSmyth Grating	1st	~ 100 (0.8~3.0)	Ordered numerical calculations of performance evaluation for MOIRCS J and H band grisms and samples.
Volume binary (VB) grating	1st~	~ 80 (0.2~3.0)	Performing replication test by using a Si grating and test fabrications of silica VB gratings by using the new technique.
Si or Ge grism	1st	~ 80 (1.2~14)	Performed direct diamond cutting of Si grisms. Planning fabrication of a Si and Ge grisms in this November.

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