An experiment of contamination control for SOLAR-C telescopes

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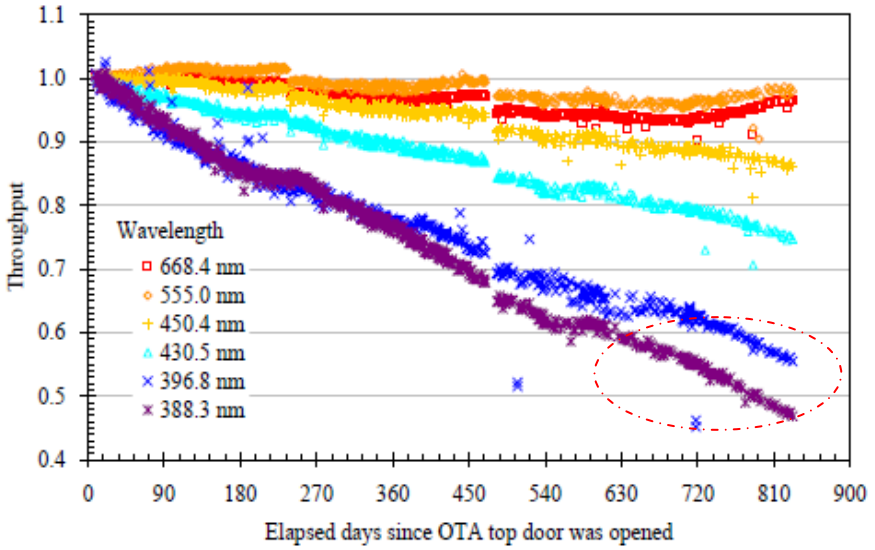
Background

- Molecular contaminants are released from organic materials.
- Due to the accumulation of contaminants on optical surfaces, the performance of telescopes is generally degraded.
- The Hinode was one of the satellites that was developed and operated under very strict contamination controls. However, it was reported that SOT throughput was degraded linearly with time since the start of observations.
- Observations in an FUV/VUV wavelength band are planned in SOLAR-C Plan-B. The FUV/VUV optics is most sensitive to molecular contamination.

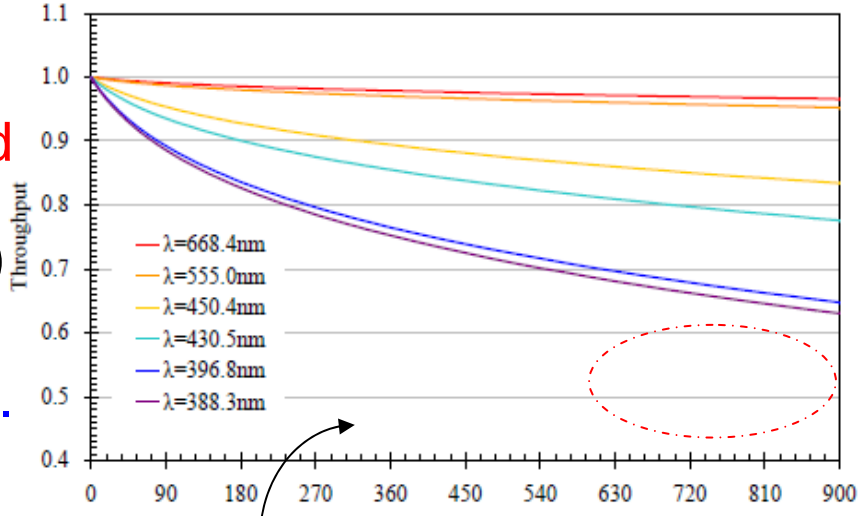
Throughput degradation of SOT

- The Hinode SOT throughput is decreasing with time. This is due to molecular contamination that was expected in the pre-launch analysis.



Observation

- The speed of degradation is faster than expected. The throughput is largely dropped at short wavelengths.
  (Not critical for observations)
- Enhanced absorption may happen at short wavelengths.



• Prediction from mathematical contamination model developed for SOLAR-B project before launch.

Discrepancy from model prediction

- The discrepancy of throughput change from the model prediction needs to be understood for SOLAR-C Plan-B optical telescope, because:
  - It requires a high-precision spectro-polarimetry to observe chromospheric magnetic fields.
  - It may have an observing band at UV wavelength where the telescope optics is easily degraded by molecular contamination.

Examples of throughput change by molecular contamination

Contaminant FUV/VUV transmittance

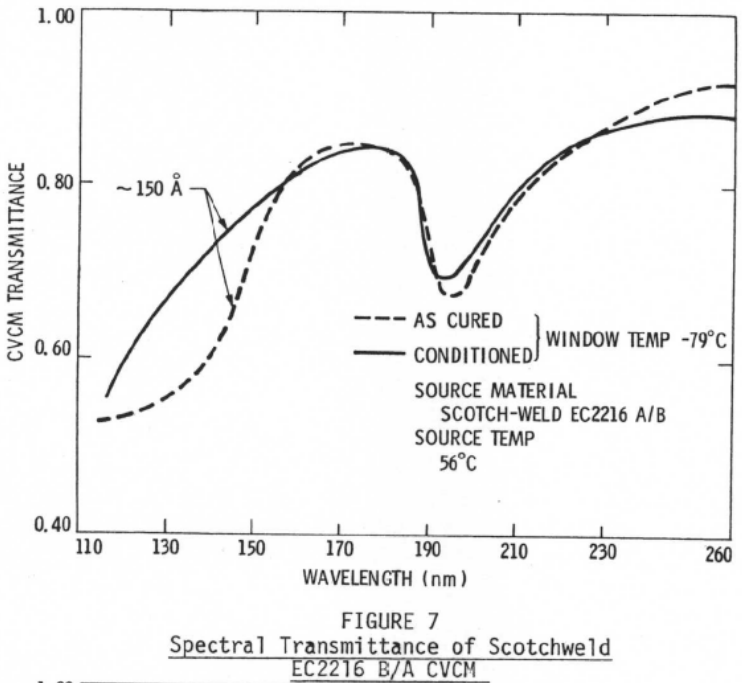


FIGURE 7
Spectral Transmittance of Scotchweld EC2216 B/A CVCM

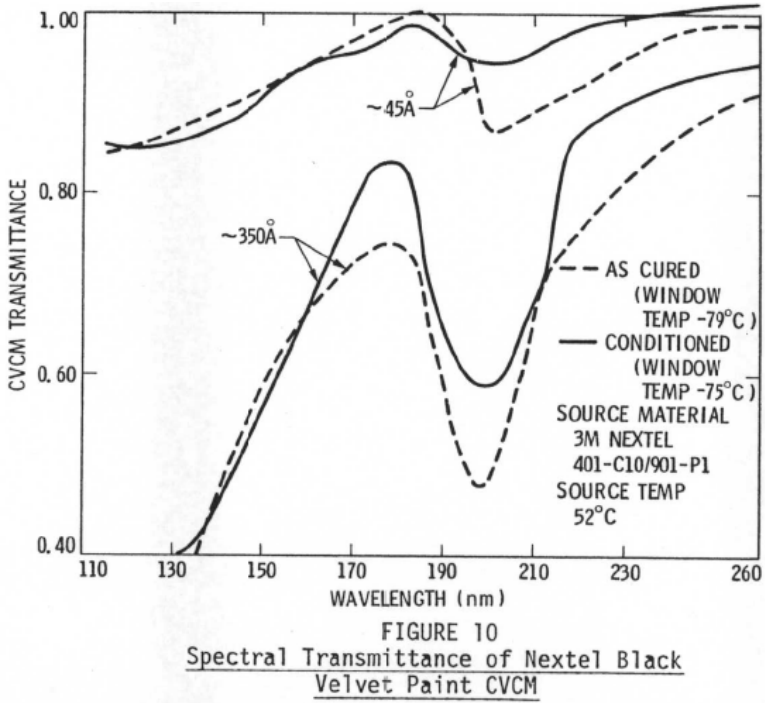


FIGURE 10
Spectral Transmittance of Nextel Black Velvet Paint CVCM

T. O'Donell, SPIE

- In the FUV/VUV region, it is well known that optical degradation becomes greater than that in the NUV/Vis region. See figure above.

Possible causes of enhanced absorption in SOT at short wavelength

1. A higher outgassing rate than the pre-launch value that was measured for the flight optics.

2. A higher deposition rate to optical surfaces than that in prediction.

→ Focus

3. Misunderstanding of absorption coefficient for contaminants.
   - A larger absorption coefficient at shorter wavelengths.
   - An enhancement of absorption coefficient by UV irradiation, that is, UV darkening.

Measurement of absorption coefficient and its change by UV irradiation **at JAXA Tsukuba**

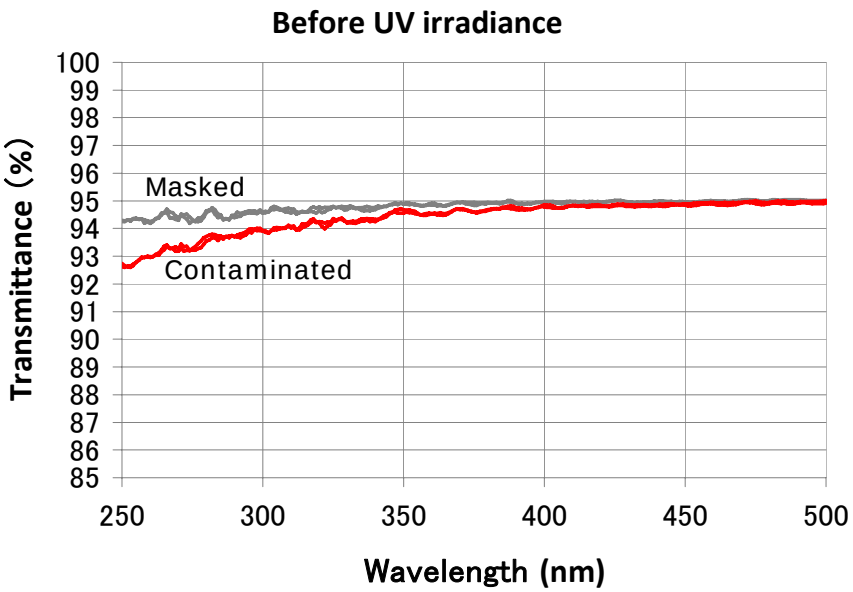
Chamber to make contamination samples.

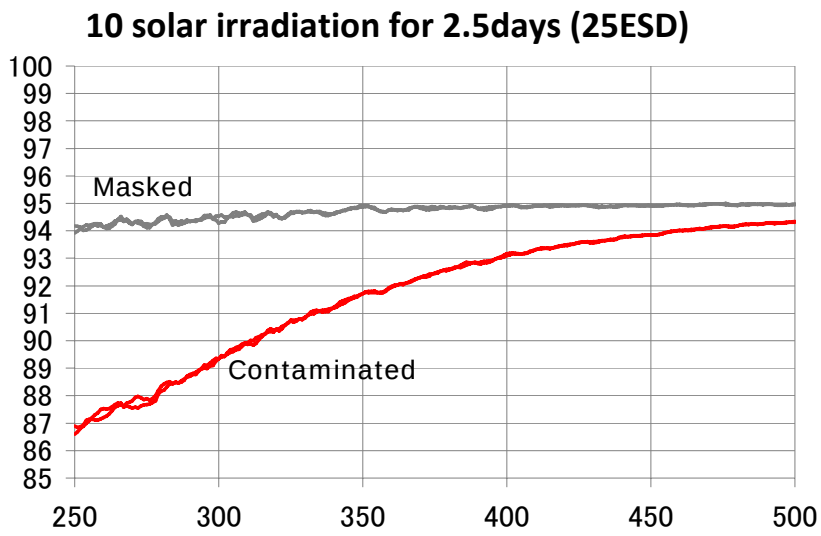
10 solar UV irradiation

Spectrophotometer (measurement of transmittance)

Degradation by the UV irradiance:

sample contaminant: DEHP

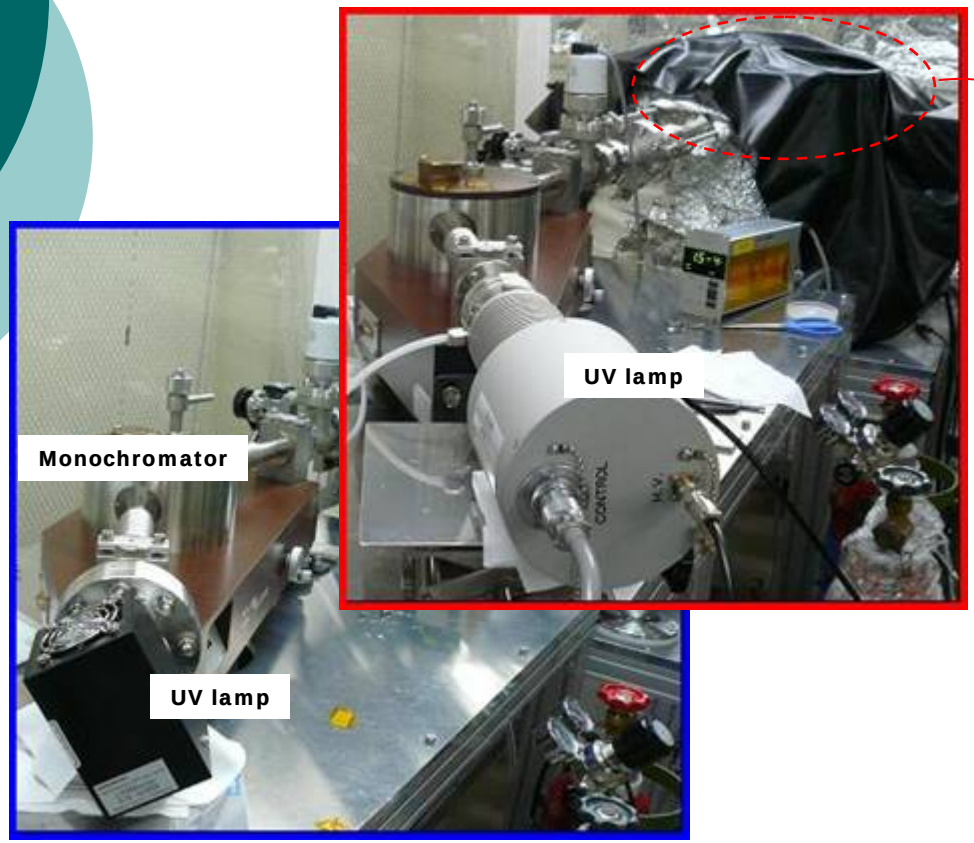


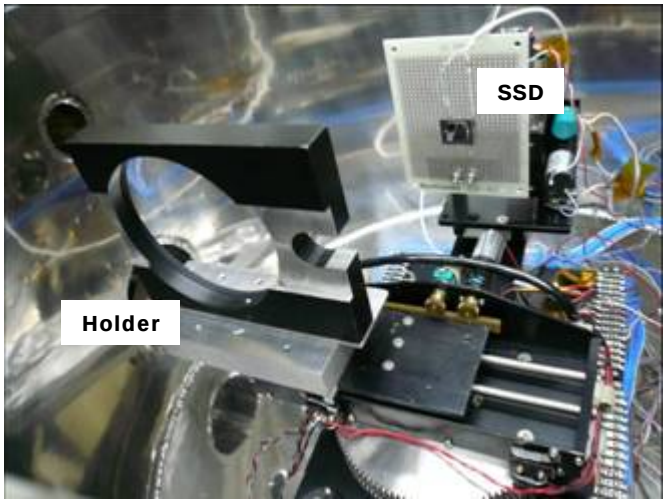


Sample: Diethylhexyl phthalate(DEHP) deposited on MgF2 plate.

- Lower transmittance was observed in shorter wavelength. (UV darkening?)
- Data are being analyzed.

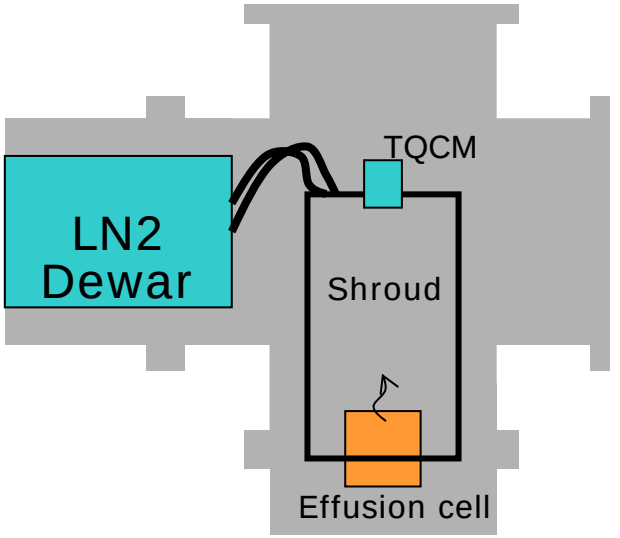
Measurement of transmittance at VUV wavelength (110-200 nm) **at NAOJ**





- Transmittance at VUV wavelengths is measured with a VUV monochromator that has a UV lamp as a light source. The UV lamp emits UV photons near 122nm and 173nm.

A new chamber to measure outgassing rate **at NAOJ**



- A vacuum chamber to measure the outgassing rate easily is under preparation by SOLAR-C group at NAOJ.
- Geometry of effusion cell and TQCM outgassing sensor is the same as that defined in ASTM-1559 standard.
- Shroud is conductively cooled down by LN2 Dewar.

Summary

- The throughput of Hinode SOT is decreasing due to molecular contamination.
- Investigations on the throughput decrease are going on.
- An experiment, which focuses on measuring the absorption coefficient of contaminants on optical surfaces, has newly started.
- We will answer through this kind of experiment for SOLAR-C telescopes.
  - How severe the SOLAR-C contamination control is, compared with Hinode.
  - Whether the “Solar” UV telescope can be made of CFRP.
- We think that these are issues of major concern on the feasibility of the Solar UV telescope.