Spatial Contamination

Contamination of space systems can lead to a real degradation of their performance (e.g. loss of reflection from mirrors, loss of transmission from lenses, increased scattering on the optical path...). It is therefore important to be able to detect the presence of contamination in these space systems.

There are two main types of contamination: particulate contamination and molecular contamination. Particle contamination corresponds to a solid substance, the size of particles generally ranges from ten nanometers to millimeters (e.g. dust during assembly, integration and storage, human sources, particles produced during spacecraft propulsion...). Molecular contamination is defined as any contaminant with no observable dimension. Its main sources are the products degassed by organic materials coming either from the components initially present or from their decomposition products (solvent, resin, glue...).

The measurements presented here were carried out within the framework of the study of contamination of optics intended for space use. The aim was to understand the impact of molecular contamination onto the stray-light.

As we would like to understand the impact of molecular contamination, we realised two high specular BTDF measurements. One on a contaminated sample and an additional one on the same sample after cleaning.

The sample (window) is made of SiO2. The window is within a metal frame. The surface roughness of the window is in the range of 3nm to 1,5nm.

Figure 1: Picture of the sample (Window diameter = 20 mm ; Window Thickness = 1,5 mm)

Measurements are performed in transmission with an incident wavelenght of 638nm and an angle of incidence of 0°. A measurement without the sample (signature) is also realised.

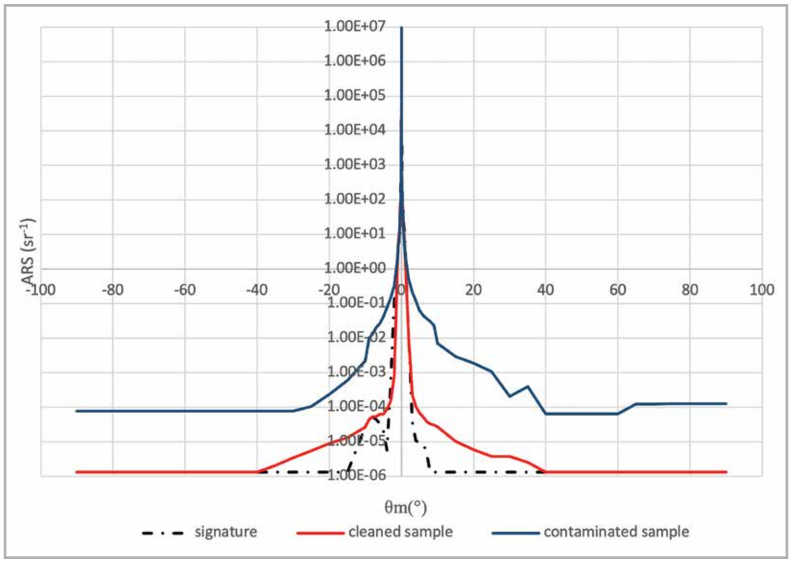

Figure 2: ARS of the contamined and cleaned sample compared toPicture of the sample
(Window diameter = 20 mm ; Window Thickness = 1,5 mm)

The specular bench can detect very low level of scattering. In this case, the minimum ARS level is 10^{-6} sr^{-1}. Thanks to that property, we are able to detect residual scattering for the cleaned sample (red curves).This scatterring is probably linked to a residual contamination and also to the surface roughness. So, we are able to detect surface roughness around 3nm to 1,5nm.

In addition, thanks to the great dynamic of the specular bench (1013), we are able to detect and above all quantify the contamination ratio of the sample. Indeed, we observe a gap of 2 decades between the contaminated (blue curve) and the cleaned sample (red curve).

These results prove that the specular bench is an appropriate tool for studying and checking the molecular contamination of space samples. In view of these conclusions, it can obviously also be used to study particulate contamination.