VUV/EUV TRANSMITTANCE AND LIGHT SCATTERING CHARACTERIZATION OF CONTAMINATED OPTICAL COMPONENTS

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Abstract

VUV and EUV spectral ranges are fundamental for space astrophysics and especially solar physics missions since they allow study of the atmosphere of the Sun and other stars. For a consistent interpretation of all in-flight data, scientists require optimal performance of their instruments during their lifetime in-orbit. However, some degradation such as loss of signal, increased noise and spectral shifts, stray light or linearity distortion may occur and distort the observations as it was the case for some space telescopes (e.g. EIT/SOHO or EUVI/STEREO). Residual molecular and particulate contamination on sensitive surfaces can explain the performance loss: the main effects of the deposits are either absorption at critical wavelength or scattered light or both. However, these effects are generally poorly known particularly in EUV and depend strongly on the nature and texture of the contaminants resulting in a complex mixture. So it is very important to improve knowledge and understanding of the contamination impact. This will be helpful to develop a better approach for the selection of the materials used in optical instruments, to quantify acceptable cleanliness levels and thus to implement appropriate measures in the cleanliness and contamination control plan to mitigate the risks (modelling, ground protection, cleaning, use of repellent coatings…).

Within this context, a CNES/IAS study has been carried out in the frame of the development of the Extreme UV Imager (EUI) aboard ESA Solar Orbiter satellite which will be launched in 2020. This instrument consists of two High Resolution Imagers and one Full Sun Imager designed for narrow pass-band EUV imaging of the solar corona at wavelengths 17.4 nm, 30.4 nm and 121.6 nm, all highly sensitive to contamination. The purpose of this joint experimental study was to assess transmittance loss and scattering effect of different representative optical components of those used for EUI (metal filters, Lyman-α filters and multilayer mirrors) contaminated at CNES at different levels by the outgassing products of three polymer materials (epoxy resin, carbon fiber/polycyanate resin and silicone elastomer). Since the optical characterization of EUV instrument components requires a very intense, continuous spectrum and a clean, small and collimated light source, only a synchrotron source can satisfy these criteria. Therefore, transmittance and BRDF measurements were performed under high vacuum using the SOLEIL synchrotron Metrology and DISCO beamlines.

This paper will describe the contamination process and the measurement protocols and report an overview of the recent results of performance loss of the tested optical components before and after contamination. Moreover, some of them have been analyzed after a long exposure to EUV-visible radiations to characterize the irreversible degradation due to photo-polymerization of the organic deposits.

References