ABSTRACT

BepiColombo is the joint mission of the European Space Agency (ESA) and the Japanese Aerospace Exploration Agency (JAXA) to explore the planet Mercury. The European contributions, namely the Mercury Transfer Module (MTM) and the Mercury Planetary Orbiter (MPO), are both powered by deployable solar arrays. Many materials and technologies are at their limit under the harsh high-intensity, high-temperature (HIHT) conditions of the mission. Synergistic effects like photo fixation and photo enhanced contamination by ultra violet and vacuum ultra violet radiation (UV/VUV) on sunlit surfaces are considered to play an important role in the HIHT environment of the BepiColombo mission [1].

The design verification test (DVT) under UV/VUV conditions of sun-exposed materials and technologies on component level was part of the overall verification and qualification of the solar array design of the MTM and MPO presented in previous work [1].

Solar cell assemblies (SCAs), Optical solar reflectors (OSR) and other types of functional materials have been exposed to representative BepiColombo environment. Present work consist of further exposure of OSR samples and detailed analysis of results from DVT test focusing on degradation of OSR’s performance.

The surfaces of OSRs and cover glasses have been analysed after long duration UV and VUV exposures at high temperature. Samples were exposed to UV and VUV intensities up to 10 solar constants, and temperatures up to 240°C. During the testing, changes in the functional properties of the materials were observed, including increase in solar absorptance for the OSRs and transmission loss for the cover glasses. This has implications for the overall performance of the solar array, such as possible temperature increase or solar cell power loss.

The aim of our work was to investigate the degradation mechanisms involved, using detailed surface analysis techniques such as X-ray photoelectron spectroscopy (XPS) and Secondary-ion mass spectrometry (TOF-SIMS) depth profiling. Contamination witness samples exposed together with the main DVT test item hardware, and the surface chemistry of the samples was analysed in detail. Results from different exposures will be presented, with varying UV dose and temperature, and possible degradation mechanisms will be discussed. The environmental conditions during the testing were also monitored in detail in order to determine possible correlation of results from surface analysis with the observed degradation. This included detailed characterisation of the in-situ contamination environment using quartz crystal microbalances (QCM) and contamination witness plates. Considerable effort was also made to accurately measure the UV and VUV intensity on the samples and the methodology used will be summarised.

REFERENCES