

SOLAR PROBE + MISSION: VUV RADIATION COUPLED TO HIGH TEMPERATURES ON CARBON/CARBON COMPOSITES

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ABSTRACT

For the next exploration of the sun, missions like Solar Probe+ (NASA) or Phoibos (ESA) will be launched to answer to fundamental questions on the solar corona and solar winds. The main objectives are the determination of the structure and dynamics of the magnetic fields at the source of solar winds, how is heated the solar corona and the consequent effect on the acceleration of solar winds... Such missions that will pass very close to the sun, respectively at 9.5 and 4 solar radii, need heat shield to protect the payload with the instrumentation. Carbon/carbon composites can withstand the severe environment encountered during the pass of the sun.

In order to reproduce partially these extreme conditions, high vacuum, high temperature on materials exposed to bombardment with energetic particles (hydrogen or/and helium ions) and VUV irradiation have to be implemented on ground simulation facilities. In this way, the MEDIASE facility was designed in collaboration with CNES and installed at the focus of the 1 MW solar furnace of PROMES-CNRS laboratory. This set-up allows heating samples up to 2500 K, under high vacuum (10^{-7} hPa), with maximal ion flux of 5 keV and 10^{16} ions.m⁻².s⁻¹ and VUV photons flux up to 10^{18} photons.m⁻².s⁻¹ for the H Lyman α line. This set-up is instrumented to carry out *in situ* measurements using a quartz crystal microbalance, an open source mass spectrometer, a pyro-reflectometer for true temperature measurement and a radiometer to measure the thermo-radiative properties of the materials that are conditioning the thermal equilibrium of the heat shield – particularly the α/ϵ ratio of the solar absorptivity α to the total hemispherical emissivity ϵ .

Several C/C composites and one grade of polycrystalline graphite were studied. Results on the combined interaction of high temperature and VUV radiation are presented and compared to the only effect of high temperature heating on the tested materials. According to the elaboration method and post-thermal treatment during the whole elaboration processes of the composite materials, some differences in the physico-chemical behavior of such samples are shown.

Before and after the treatment of the samples, analyses are performed using several adapted techniques such as SEM, XRD, Raman... An important effect of the VUV radiation was observed if compared to the only high temperature treatment that can affect the measurements done by the payload instrumentation.