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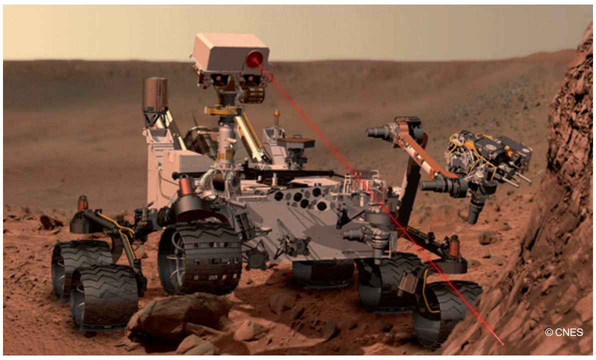
Zeolite objects for molecular decontamination in space



Over the years, maintaining the performance of satellite systems has become more and more demanding. The space industry has implemented major research programs in order to control all the parameters that govern the molecular contamination of critical surfaces. In fact, the longevity of the on-board instruments, such as the optics or thermal control coatings, can be drastically reduced by the phenomena of particulate and molecular contamination.

During the assembly of a satellite, it is essential to first degas the constituent materials since these can generate pollutant molecules (for example from lacquers or paints) being deposited on the surface of the instruments mentioned above. In addition, the presence of ultraviolet radiation causes a photochemical attachment of contaminants to the surface of materials therefore degrading their thermo-optical properties. Fortunately, there are many ways of reducing the risk of pollution. Generally, an extensive vacuum pre-degassing of the materials is carried out. However, this method is expensive, time-consuming and inefficient for countering the contamination that occurs during the satellite launch (environment of the nose of the launcher, the phenomenon of loss of air pressure and launcher apogee motors).

It is in this context of seeking to control the molecular contamination that the use of molecular adsorbents in flight looks like a first-class alternative. Because of their specific surface area, lightness and high thermal stability, porous solids do indeed offer many advantages.

For twenty years, the US space agency ("NASA" - "National Aeronautics and Space Administration") has been carrying out research that has identified a family of porous materials that are effective for the retention and trapping of the degassed pollutant molecules in orbit. The WFPC-2 project (Wide Field/Planetary Camera 2) of 1994, initiated by "NASA", aimed to limit the condensation of chemical species on the surface of an on-board CCD camera. It was then proved that alumina, mesoporous silicas and active carbons did not effectively retain the pollutant molecules due to the unsuitable geometry and size of their pores and the sometimes low concentration of these pollutants. In contrast, zeolites, because of their microporous structure compatible with the size of the target molecules, have proved to be very beneficial for controlling molecular contamination in orbit. In this case, the 13X zeolite (FAU) helped to halve the contamination of the camera studied (1).

That is why this issue is the subject of a permanent collaboration between the National Centre for Space Studies (CNES) and the Controlled Porosity Materials (MPC) team at the Institute of Science of Materials of Mulhouse (IS2M). Indeed, the previous three theses produced in the laboratory and initiated by the French Space Agency have been able to select the structural types MFI, FAU, EMT and BEA* as zeolites presenting the most beneficial adsorption and retention properties (2). In a second phase, the shaping of these zeolites, usually used in powder form, was also studied.

1. J.B. Barengoltz, S. Moore, D. Soules, G. Voecks. 1994, Jet Propulsion Laboratory Publication, Vol. 94, p. 1.

2. H. Kirsch-Rodeschini. 2006, Molecular Contamination Control by Adsorption on Porous Solids, PhD of the University of Haute Alsace.