RED 4 MARS

By Rafal Anyszka

Designing rubber for long-term Mars exploration

The interest in Mars exploration is now greater than has ever been in human history. New technologies allow reaching Mars's surface safely, and the research performed there is more and more sophisticated. The missions, which are done on the Mars surface last much longer than in the early days of exploration. For example, the Curiosity rover mission has lasted for over 10 years and it's still ongoing. Such a long time of operation in an environment drastically different from Earth's conditions affects the properties of the materials used to a significant extent.

One of the most unique materials in engineering applications is rubber. Its viscoelastic properties make it an irreplaceable material for many applications, like tires, dampers, gaskets, hoses, etc. The growing interest in Mars exploration will require the development of new equipment that can withstand Martian conditions for a long time. Inevitably, rubber elements will be part of such equipment. Therefore, designing rubber that could successfully withstand Martian conditions is of significant interest.

The aim of this work is to develop new rubber compounds based on butadiene (BR) and silicone rubber (VMQ) blends, that would preserve good elasticity in low temperatures present on Mars, simultaneously assuring satisfactory mechanical properties (given by BR) and UV resistance (given by VMQ). The thermodynamically immiscible blends are chemically compatibilized and filled with functional fillers to provide a homogeneous micromorphology and good dynamic-mechanical performance.

Relevance to the proposed abstracts:

Mars Life Explorer – the proposed lander will be equipped with a drill. The drilling will cause vibrations that may affect the functioning of other devices. Rubber dampers exhibit the best vibration reduction performance.

Collecting In Situ Observations of Meteorological and Aeolin Processes on Mars – the small science payload planned to deliver on the surface of Mars to perform the in-situ measurements may suffer from vibrations, which can be reduced by the use of rubber dampers.

Abzu: A Mission to Uncover the Origin of Ancient Organics on Mars in situ – The lander will be equipped with a grinder that might generate vibrations, which can be reduced by the use of rubber dampers.

Key Technology Needs Identified from KISS Report – The project involves the study of hard-landing instruments. Rubber is a perfect material to provide damping during the impact, for example in form of inflatable rubber balloons. Also, the use of rovers will be studied – in this case, the use of rubber tires/tracks allows for increasing the speed of rovers significantly.

Mars Polar LAnder and ClimatE Record Network (Mars PLACER Net or MPN) – Properly designed rubber elements would assure the best impact and vibration protection during the MarsDrop procedure.

TH2OR Electromagnetic Sounding For Subsurface Brines On Mars – the ballistic deployment system described in the proposal will require an effective damping system, especially in the lower gravity of Mars. Properly designed rubber elements would ensure the best reliability for such a system.

Mars Icebreaker – The drilling and sample-delivering systems will generate vibrations, which can be reduced by the use of rubber dampers.

ASTROLAB: A South Pole-Aitken Basin Sample Return Mission Using Commercial Rovers and Landers – Properly developed rubber can be used as a damping system for the relatively large rovers that are foreseen for the mission.

This technology is based on the currently realized project RED 4 MARS:

https://www.utwente.nl/en/et/ms3/research-chairs/ete/research/current-projects/red-4-mars/