BUTADIENE RUBBER BLENDS FOR MARS MISSIONS

Rubber is a unique material, which combines elastic and viscous properties. Because of this it is irreplaceable in many technical applications, like seals or tires. Future plans of Mars exploration involve sending heavy equipment and even human crews. To assure safety of the crew and high performance of the equipment, rubber elements must be integrated in the future Mars missions. However, designing rubber materials to be applied for Mars missions is a challenging task. The Mars environment is much more demanding than that from the Earth with a daily temperature amplitude reaching up to 100°C and varying from -140°C in the polar regions to +30°C during a summer day. Also the atmosphere density on Mars very thin, only ca. 0.5% of Earth's, which results in much lower atmospheric pressure. Because of the lack of magnetosphere and an ozone layer Mars surface is exposed to particular and UV radiations, respectively. All these factors combined constitute a demanding environment for rubber materials, which need to exhibit elasticity in wide range of relatively low temperatures, high radiation resistance, and have to be produced with non-volatile ingredients, which could evaporate under the low pressure of Mars. This assignment aims to support this development by performing tests with different Butadiene Rubber (BR) blends exhibiting stable elastic properties in a wide range of temperatures and be able to withstand low-pressure and high-radiation environment.

Objective

The objective of this assignment is to develop and test rubber compounds based on two types of BR – one preserving elasticity at lower temperatures but prone to crystallization, and another one having worse low-temperature elasticity but being non-crystallizable. Crystallinity affects the elastic properties of rubber to a significant extent (Fig. 1) resulting in a non-stable rubbery behavior in the daily temperature range on Mars. Therefore, by blending these two rubber types one hopes to improve the low-temperature elasticity without triggering crystallization.

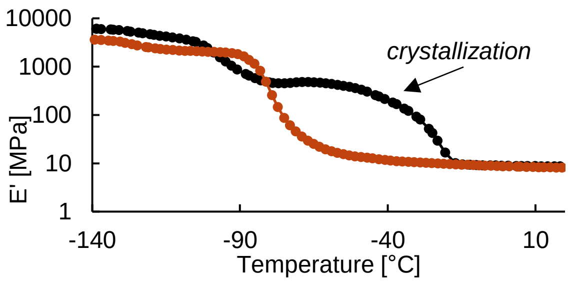

Fig. 1: *Comparison of the Dynamic Mechanical Performance of* ***crystallizing*** *and* ***non-crystallizing*** *BRs*

Assignment

At the beginning of the assignment, the student will propose in consultation with the supervisors the rubber formulations. Based on the formulations rubber compounds will be prepared and tested from the point of view of their viscoelastic behavior in a wide range of temperatures. The compounds will be optimized by changing the crystallizing/non-crystallizing BR ratio, type, and amount of fillers and additives.

The practical work will be performed in the laboratories of ETE at the UT.

Report

The graduation report should contain: **1.** The reasoning behind choosing the BR compositions and their additives; **2.** Rubber composites preparation procedure; **3.** Testing results, their evaluation, discussion, and conclusions.

Start: Lab work: earliest - March 1st, 2023, theoretical work can start earlier

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References

R. Anyszka, N. Nizel, M. Maciejewska, D. Bielinski, L. Jia, A. Blume: *Rubber for Mars: Optimization of BR/VMQ compounds*. International Elastomer Conference, Cleveland, OH, USA, October 2023

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