LIVE WEBINAR

Tuesday, Oct. 15, 2024, 2-4pm CET

FREE OF CHARGE

TOPIC

-Influencing Lifetime of Rubber-
Advances in Understanding
Thermal Effects in Rubber

3rd lecture event

This webinar relates to our book „Advances in understanding thermal effects in rubber: Experiments, Modelling, Practical Relevance”
https://lnkd.in/gnQgBCkF

Agenda: This currently very important topic will be comprehensively presented in the following 3 lectures by:

Prof. Jean-Benoît LE CAM
Université de Rennes, France
Thermomechanical and Energetic Behavior of Elastomers Investigated with IR Thermography

Dr. William V. MARS
Endurica LLC, USA
A Review of Thermal Effects on Elastomer Durability

Assoc. Prof. Radek STOČEK
Centre of polymer systems, Tomas Bata University in Zlín, Czechia
Kinetics of Self-Heat Build-Up in CB Filled Natural Rubber

Time schedule:

2:00pm - 2:10pm - introduction by **Prof. Dr. rer. nat. habil. Gert HEINRICH**
2:10pm - 2:45pm - lecture given by **Prof. Jean-Benoît LE CAM**
2:45pm - 3:20pm - lecture given by **Dr. William V. MARS**
3:20pm - 3:55pm - lecture given by **Assoc. Prof. Dr.-Ing. R. STOČEK**
3:55pm - 4:00pm - farewell by **Prof. Dr. rer. nat. habil. Gert HEINRICH**

Abstracts

Prof. Jean-Benoît LE CAM
Université de Rennes, France

Thermomechanical and Energetic Behavior of Elastomers Investigated with IR Thermography

This chapter discusses the use of the surface calorimetry approach to study rubber deformation. It introduces the theoretical framework for determining heat source (or heat power density) from full temperature field measurements and the heat diffusion equation. The determination of the mean intrinsic dissipation and the strain-induced crystallinity from the heat sources is presented and discussed. Typical results obtained under homogeneous tensile loadings are reviewed and analyzed according to four types of calorimetric responses. The types of responses depend on whether the rubber is filled or not, and whether it is crystallizing or not. The calorimetric signatures of thermo-elasticity, viscosity, strain-induced crystallization, stress softening and energy storage are analyzed and discussed.

Dr. William V. MARS
Endurica LLC, USA

A Review of Thermal Effects on Elastomer Durability

The low thermal conductivity of elastomers means that frequently the materi-al operates subject to a temperature gradient with high temperatures in the in-terior. Other times, elastomers are called to operate directly in higher tem-perature environments which can affect their properties or invoke aging. Thus, the temperature impact on material behavior is an important considera-tion in characterization and analysis. Temperature has many influences that can strongly impact structural response and durability, both in helpful and in detrimental ways. These include: elastic and dissipative properties, thermal expansion/contraction, strength and crack growth properties, strain crystalli-zation, ageing and the resistance to thermal runaway. There are at least two parameters without a temperature sensitivity: intrinsic strength and crack pre-cursor size. This review considers the characterization and modeling of the impact of temperature on durability, and includes examples computed with the Endurica fatigue solvers.

Assoc. Prof. Radek STOČEK

Centre of polymer systems, Tomas Bata University in Zlín, Czechia

Kinetics of Self-Heat Build-Up in CB Filled Natural Rubber

The fact that heat is generated in viscoelastic materials like rubber progressed by energy dissipation while cyclically loaded is well known as self-heat build-up (HBU). In addition, the rubber components are reinforced with various types of fillers, the most used being carbon black (CB), which significantly affects the viscoelastic properties and therefore the development of heat. The exact course of heat generation depending on individual load cycles has not yet been sufficiently described in general terms, let alone defined with regard to the influence of different types of CB. More detailed knowledge would therefore be of great importance for the development of materials for many rubber applications. For this reason, the aim of this study is to describe in detail the kinetics of HBU in natural rubber reinforced with 10 different types of CB under varied cyclic loading conditions. In order to understand the effect of different filler reinforcements on the HBU behavior, the fundamental characterization of the studied materials, namely hardness, tensile properties as well as the determination of viscoelastic behavior with respect to the Payne effect, was first performed. The kinetic of HBU was characterized using a unique method of cyclic alternating tensile and compressive loading of a rotating bent rubber cylinder with in-situ temperature analysis inside as well as on the surface of the sample. Simple mathematical functions describing the heat evolution as a function of the type of CB and loading frequency were defined and these were discussed in relation to the fundamental properties of the materials studied. An increasing temperature rise with increasing CB volume as well as aggregate surface area has been found which fully corresponds with increasing hardness and stiffness of the rubber. Moreover, it has been shown that the course of HBU kinetics as a function of CB type and amount is fully consistent with the G'' values obtained in the Payne effect analyses.

Speakers

Prof. Jean-Benoît LE CAM

Jean-Benoît Le Cam received the M.Eng. degree in mechanical engineering from Conservatoire National des Arts et Métiers, Orléans, France, in 2002, the M.S. degree in applied mechanics from Ecole Centrale de Nantes, France, in 2002, and the Ph.D. degree in mechanical engineering from Ecole Centrale de Nantes and University of Nantes, France, in 2005. From 2006 to 2011, he was an Assistant Professor at the French Institute of Advanced Mechanics (IFMA), Aubière, France, where he worked on mechanics of elastomers. In 2010, he received his habilitation on thermomechanical characterization of elastomers and was appointed director of the Structures and Mechanics of Materials department at IFMA. Since 2011, he is a Professor at Institute of Physics Rennes, University of Rennes (UR), France, where he is the leader of the Quantitative Imaging in Mechanics of Materials Group. From 2015 to 2020, Prof. Jean-

Benoît Le Cam held the Cooper Standard Chair in mechanics of elastomers at UR and managed the Research Laboratory (LC-DRIME) in Imaging, Mechanics and Elastomers, common to Cooper Standard, UR and the National Center for Scientific Research. Since 2021, he manages the Research Laboratory (ELAST-D3) for the development, the durability and the dynamic properties of elastomers, common to Continental, UR and the National Center for Scientific Research."

Dr. William V. MARS

Internationally accomplished entrepreneur / scientist with focus on failure mechanics and constitutive behavior of elastomers, material characterization and product simulation. Founder and President of Endurica LLC, provider of durability management solutions for elastomers. Experience includes 30+ years in the rubber industry, and development and teaching experience for graduate / professional level courses. Published work includes ~60 articles in refereed journals and 4 patents/patents pending. Past editor of Rubber Chemistry and Technology, and Tire Science and Technology. Sole inventor of the first critical plane analysis of fatigue life for elastomers. Recipient of the ACS Rubber Division's 2007 Sparks-Thomas award "for outstanding contribution to the science and technology of elastomers, for originality and independence of thought, and for technological impact of the nominee's contribution" and the 2022 Harold Herzlich Distinguished Technology Award.

Assoc. Prof. Radek STOČEK

Radek Stoček obtained his diploma degree as engineer in 2005 from the Czech Technical University in Prague and received his Ph.D. in engineering science in 2012 from the Technical University Chemnitz (Germany), working with M. Gehde and parallel with G. Heinrich at IPF Dresden (G). Then he started an industrial career at Polymer Research Lab (PRL), Zlin, Czech Republic, which is a subsidiary of the testing equipment producer Coesfeld GmbH, Germany and parallel an independent academic career at the Tomas Bata University (TBU) in Zlin. He finished his Habilitation in 2019. Currently he is holding the two positions as General manager at PRL and Head of the Rubber Department at TBU. His research and scientific interests are focused on characterization of rubber material properties with respect to fatigue and fracture mechanics and on the development of new and advanced testing methodologies, hardware and equipments. One main goal is to optimize industrial rubber products in terms of performance and durability as well as to fasten development cycles and minimizing extensive real rubber product tests before production. His work has been recognized by awards from The Tire Society (USA) and recipient of the ACS Rubber Division's 2023 Sparks-Thomas award "for outstanding contribution to the science and technology of elastomers. R. Stocek is author of 74 publications (according to Scopus).

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