Karlsruhe Institute of Technology

CoDiCo FRP

# Seminar series of the Graduate School GRK 2078

---


Referee: **Dr. Prateek Sharma**
Post Doctorate, Chair of Applied Mechanics
Saarland University, Saarbrücken
Group Leader: Polymers


Date: Tuesday, 28.05.2024

Time: 14:30-15:30h

Location: Zooom-Meeting

Title: **Crack propagation in viscoelastic materials during relaxation**

---


**Abstract**

P. Sharma, S. Diebels

Saarland University, Saarbrücken, Campus A 4.2, 66123, Germany

Crack propagation in a material is usually because of the mechanical deformations exceeding a critical threshold, leading to the conversion of available strain energy into the creation of new crack surfaces. When a polymer is held at a constant deformation, then a reduction in the energy of the system, or the relaxation, till an equilibrium state is expected. However, relaxation experiments conducted on crosslinked polymers have shown instances of failure before equilibrium is attained [1]. One plausible explanation for the failure is the different chain length distributions within the polymer structure. During the initial loading phase of relaxation specimens, shorter chains may fracture, while longer chains may partially relax and redistribute the load to the remaining chains. The absence of shorter, relaxed chains in this load transfer process may result in an overload on the remaining chains, ultimately leading to failure.

An experimental investigation on this failure behaviour dependent on the initial strain and the strain rate is presented. Different materials, namely polyurethane and rubber, are tested and the conditions are defined under which failure is observed. A numerical model is implemented to understand the phenomenon. The viscoelastic behavior of the polymer is simulated using a rheological model incorporating the evolution of an inelastic strain as an internal variable. This mechanical model is coupled with a phase field approach to simulate failure and crack propagation within the material. The evolution of the phase field variable, governed by the Ginzburg-Landau equation, enables the modeling of failure progression during relaxation [2]. Thus, this study offers both experimental and numerical analyses of the failure mechanisms in crosslinked polymers subjected to constant deformation.

[1] S. Neuhaus, H. Seibert, S. Diebels. In: Engineering Design Applications II. Advanced Structured Materials, 113, A. Öchsner, H. Altenbach (eds), Springer, Cham. (2020).
[2] P. Sharma and S. Diebels. "Modelling crack propagation during relaxation of viscoelastic material." Journal of Materials Science 58.14 (2023): 6254-6266.

You are cordially invited to take part in the event!

Prof. Dr.-Ing. Thomas Böhlke
(Spokesperson of GRK 2078)