Seminar im Rahmen des GRK 2078

Referee: **Valerian Hirschberg, Doctoral Student**
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Date: Tuesday, July 31, 2018
Time: 14:00 h

Location: Bldg. 10.23, 3rd Fl. (R 308.1 - KM-Seminar Room)

Title: **Fatigue Analysis of Polymers via Fourier Transform of the Stress**

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Abstract

In this work, the stress response of mechanical fatigue testing on polystyrene (PS) of different molecular weight *M* in oscillatory torsion was analyzed via Fourier transform (FT), to determine fingerprints of continuous fatigue. The tests were performed in the solid state at room temperature using a torsion rectangular geometry (notched rectangular samples) and were filmed by a video camera to visualize changes in the samples such as cracks. First, the influence of molecular weight was determined via Wöhler curves. Secondly, large strain amplitudes were applied, so the stress response was nonlinear and higher harmonics could be detected in the FT spectra. The idea is to analyze the time evolution of the stress via linear parameters (storage (*G'*) and loss (*G''*) moduli), nonlinear parameters (higher harmonics) and their derivatives. These parameters were used to better understand and further analyze fatigue, to detect and describe specific events such as crack initiation and propagation and to predict the fatigue lifetime. The results show that during a test, the linear parameters *G'* and *G''* were found to monotonically decrease, while the $I_{3/1}$ intensity (relative amplitude of the third harmonic to the first one) increased steadily up to a maximum at failure. For all the parameters followed, their behavior over a specific time frame, shortly after the beginning of the test, was found to be linear with time (number of cycles). The fatigue lifetime was found to follow a power-law function of the (time dependent) rates of change (slopes) of *G'*, *G''* and $I_{3/1}$ in this regime. Additionally, for undamaged samples, the nonlinear parameter $I_{2/1}$ (relative amplitude of the second harmonic to the first one) is within the noise level, but its intensity increased when (visible) defects were created (macroscopic cracks). Moreover, the sum of the nonlinearity *Q* ($Q=I_{3/1}/\gamma_0^2$) until failure was calculated and correlated with the fatigue lifetime, resulting in a power law correlation. The time evolution of *G'*, *G''*, $I_{3/1}$ and $I_{2/1}$ are now proposed as new criteria to predict part failure and detect the onset of macroscopic cracks under the conditions tested as these parameters can better determine safety limits (partial damage) and the sum of the nonlinearity *Q* is proposed as new nonlinear failure criterion.

Alle Interessenten sind herzlich eingeladen.
Prof. Dr.-Ing. Thomas Böhlke