# BEHAVIOR OF PA6 MATERIALS AT EXTREME THERMO-MECHANICAL LOADING

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Implementation of polymers for impact energy absorption arises several fundamental questions related to *time-rate-temperature*, and *frequency-rate-temperature* interrelation. In other words, is it possible to utilize time- or frequency-dependent material functions to predict the behavior of the material at high rate impact loading?

A good base for answering these questions one could find in work by Nairn J.A. [1], where discussion on impact toughness prediction of polymeric beam by considering viscoelastic properties of material and internal damping in addition to classical elastic analysis of the beam is presented. Unfortunately, this work, like many others, doesn't take into account the effect of temperature on the properties of investigated material. However, it is well known that even small variations in temperature can significantly change the behavior of polymers.

In this paper we present the results on the behavior of structural elements (circular plates) made of PA6 material at extreme thermo-mechanical loading. Utilizing the Fourier series interrelation between the *rate-* and *frequency-dependence* of the material properties we determined the rate-temperature interdependence which allows prediction of conditions at which material exhibits the maximal impact energy absorption.

Impact experiments were executed on a special self designed and manufactured *Airgun Apparatus*. Ballistic limit of PA6 plates was found as a function of temperature and correlated with dynamic viscoelastic properties of PA6 obtained with DMA technique. DMA experiments were performed on MARS II Rheometer (Haake Thermoscientific) on polyamide solid specimens at different temperatures. The experimental results are also compared with the predictions based on viscoelastic time-dependent material functions.

[1] Nairn, J.A., *Measurement of Polymer Viscoelastic Response During an Impact Experiment.* Polymer Engineering and Science. **29**(10): p. 654-661, 1989.