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Expansion and Modulus Measurements During Shrinkage of Fibers; Simultaneous Load- and Temperature-Modulated TMA

Rudolf Riesen, Jürgen E. K. Schawe

Mettler-Toledo GmbH, Sonnenbergstrasse 74, CH-8603 Schwerzenbach, Switzerland

Abstract

The uniqueness of fibers lies in their anisotropy mainly due to the spinning and drawing process during production [1, 2]. As a result, many of the physical properties depend on the mechanical and thermal treatment and hence, are subject of thermoanalytical characterization.

The thermal behavior of a drawn PET fiber has been investigated by thermomechanical analysis, TMA, and by differential scanning calorimetry, DSC. Above the glass transition temperature of 79 °C, the fiber shrinks to a maximum of 8% of the initial length. Young's modulus, E, was measured by TMA with modulation of the tensile stress [3]. With temperature-modulated TMA [4, 5] it is possible to separate thermal expansion and shrinkage during a relaxation process of drawn fibers. Since the modulation frequencies for the measurement of the tensile modulus and the expansivity can be different by a factor of 10, it is possible to apply force and temperature modulation simultaneously during a slow underlying temperature increase. Therefore, a single TMA measurement provides all these temperature and time dependent properties of a fiber as it is shown using a poly(ethylene terephtalate) fiber. This can be used to study influences of draw ratio or other influences of thermal or mechanical treatment.

The described techniques can also be applied to samples other than fibers, e.g. solids in the penetration or expansion mode, in the bending arrangement or in cases of swelling measurements.

References

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