NAPLES, ITALY 30 JUNE - 4 JULY
ACEX2025 NAPLES
18th International Conference on Advanced Computational Engineering and Experimenting

ABSTRACT

Exploring Property Gradients in PA6: The Interplay of Structure and Moisture

A.K. Sambale[1], E. Euchler[1], M. Kurkowski[1], M. Schwartzkopf[2], M. Stommel[1,3]

[1]Leibniz Institute of Polymer Research Dresden, Germany
[2]Deutsches Elektronen Synchrotron DESY, Hamburg, Germany
[3]TUD Dresden University of Technology, Germany

The mechanical performance of semi-crystalline thermoplastics such as polyamide 6 (PA6) is strongly influenced by local variations in environmental exposure and processing conditions. Moisture uptake leads to significant changes in stiffness and toughness, while processing-induced structural differences introduce additional gradients in material properties. While both effects have been studied individually, their interplay remains largely unexplored.

This study investigates how processing-induced structural heterogeneities affect moisture distribution in PA6 and how both contribute to local mechanical property variations. Additionally, the impact of moisture on the structural evolution of PA6 is considered, as absorbed water lowers transition temperatures, potentially driving aging-related phase transformations. Structural characterization and moisture distribution measurements are used to assess spatial variations, while selected mechanical testing methods explore how these gradients influence local material behavior.

Previous studies have successfully modeled moisture distributions [1,2] and their coupling to mechanical properties, predicting stiffness and deformation behavior as a function of spatially resolved water content [3]. However, these models assume homogeneous structures. Given that both processing-induced structure and moisture uptake evolve over time, an open question remains: How do these dynamic gradients interact, and can their combined effect be meaningfully integrated into predictive models?

By combining structural and moisture gradient analysis, this study seeks to clarify how local variations in morphology and environmental exposure interact. A deeper understanding of these effects could improve material design, processing strategies, and predictive simulations, particularly for applications where polymers are subjected to fluctuating environmental conditions and long-term aging.

[1] A. K. Sambale, M. Stanko, J. Emde, M. Stommel (2021). Polymers, 13(9), 1480.
[2] A. K. Sambale, M. Maisl, H.-G. Herrmann, M. Stommel (2021), Polymers, 13(18), 3141.
[3] A. K. Sambale, M. Stanko, K. Uhlig, M. Stommel (2023), J. Appl.Pol.Sci, 140(12), e53654.