Numerical Investigation of Glass Phase Transformations: An Implementation of Kinetic Models Using ANSYS and Neighbor Element Method

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Abstract

The manufacturing processes of high-quality glass components, however, require precise control and understanding of phase transformation mechanisms, particularly during thermal processing stages.
This research introduces an advanced numerical framework for modeling glass phase transformations, incorporating both thermal and mechanical coupling effects. The implementation utilizes the commercial finite element software ANSYS, enhanced with a specialized Neighbor Element Method (NEM) approach. Our methodology focuses on capturing the kinetic aspects of phase transitions, providing a comprehensive tool for analyzing the complex material behavior during processing.

The developed model incorporates time-dependent phase transformation kinetics, enabling detailed investigation of structural changes during thermal processing. By implementing the NEM algorithm, we achieve improved representation of local material interactions and transformation phenomena. The numerical framework addresses the challenges of modeling glass transition behavior, including the complex interplay between thermal gradients and mechanical stress development.
A distinctive feature of this approach is its ability to capture the non-linear behavior during phase transitions while maintaining computational efficiency. The framework incorporates critical aspects such as structural relaxation mechanisms and temperature-dependent material properties, providing a robust platform for investigating various processing conditions. This computational tool is particularly promising for industrial applications where precise control of thermal processing and resulting material properties is essential.

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