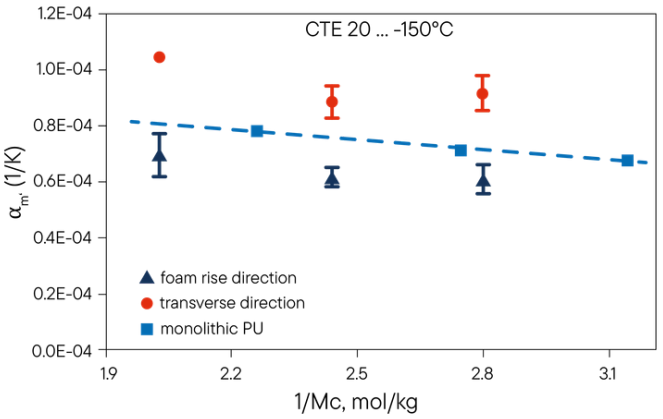
Thermal Expansion Behavior of Bio-Based Polyurethane Foams for Cryogenic Applications

Dilatometric Analysis of Bio-Based Closed-Cell Polyurethane Foams

Dilatometry enables the precise characterization of thermal expansion and dimensional changes under controlled temperature conditions. In this application example, bio-based closed-cell polyurethane foams with different crosslinking densities were investigated using the Linseis TMA L72 (former designation: TMA PT 1600). The measurements provide valuable insights into the thermal expansion behavior and cryogenic suitability of advanced insulation materials.

Measurement Setup

- Instrument: Linseis TMA L72 (former designation: TMA PT 1600)
- Sample: Bio-based closed-cell polyurethane foams
- Temperature range: +20 °C to −150 °C (3 °C/min)
- Measurement: Mean coefficient of thermal expansion (CTE)
- Application: Cryogenic insulation materials



The dilatometric measurement reveals the thermal expansion behavior of bio-based polyurethane foams under cryogenic conditions. Key observations include:

- Low mean thermal expansion over the investigated temperature range
- Clear influence of crosslinking density on CTE values
- Good dimensional stability at cryogenic temperatures
- Excellent suitability for advanced insulation applications

The results demonstrate the importance of material composition for optimizing cryogenic performance.

Interpretation

The observed thermal expansion behavior can be attributed to:

- Polymer network structure
- Crosslinking density
- Material morphology

This results in:

- Improved dimensional stability
- Reduced thermal stresses
- Enhanced cryogenic performance

Industrial Relevance

Dilatometric measurements are widely used for:

- Cryogenic insulation development
- LNG storage systems
- Hydrogen technologies
- Aerospace applications
- Material qualification
- Research and development

Conclusion

The measurements performed with the Linseis TMA L72 demonstrate the suitability of thermomechanical analysis for characterizing the thermal expansion behavior of bio-based polyurethane foams under cryogenic conditions. The results provide valuable insights for the development of reliable insulation materials with improved dimensional stability and long-term performance.

Source:
Piszczyk, Ł., Strankowski, M., Danowska, M., et al.
Thermal Expansion Behavior of Bio-Based Closed-Cell Polyurethane Foams under Cryogenic Conditions.
Adapted from measurements performed using a Linseis TMA L72 (former designation: TMA PT 1600) Thermomechanical Analyzer.