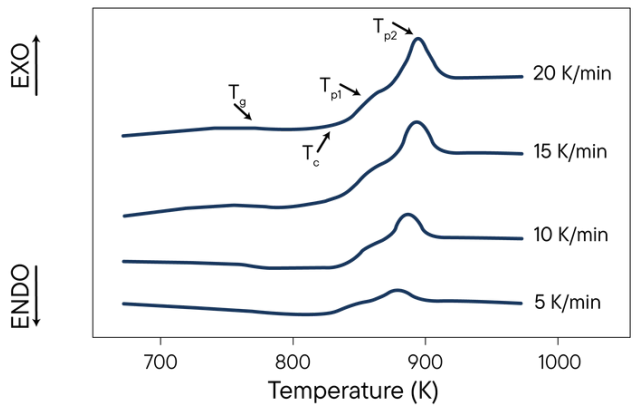
Crystallization Kinetics of a Barium–Zinc Borosilicate Glass

STA L81 Analysis of Crystallization Behavior in Lead-Free Borosilicate Glasses

Lead-free borosilicate glasses are widely used in electronic packaging, LTCC substrates, and glass-ceramic applications. Understanding their crystallization behavior is essential for optimizing sintering processes and final material properties. Using Differential Thermal Analysis (DTA), the crystallization kinetics of a BaO–ZnO–B_2O_3–SiO_2 glass were investigated. The results reveal two distinct crystallization stages and provide valuable insight into phase formation during thermal processing.

Measurement Setup

- Instrument: LINSEIS STA L81 (former STA PT 1600)
- Material: BaO–ZnO–B_2O_3–SiO_2 Glass
- Temperature Range: RT to 973 K
- Heating Rates: 5–20 K/min
- Measurement: DTA Analysis
- Application: Glass-Ceramics & Electronic Packaging



The DTA measurement reveals two distinct crystallization processes during heating.
Key observations include:

- Tg: 720–769 K
- First crystallization peak: 852–866 K
- Second crystallization peak: 879–895 K
- Formation of BaB_4O_7 and $BaZnSiO_4$ phases
- Surface crystallization dominates the process
- Crystallization progresses towards the bulk material

The results demonstrate the suitability of thermal analysis for characterizing crystallization processes and optimizing firing conditions for glass-ceramic materials.

Interpretation

The observed behavior can be attributed to:

- Two-step crystallization mechanism
- Surface-initiated crystal growth
- Temperature-dependent nucleation behavior
- Progressive transformation from surface to bulk crystallization

This results in:

- Improved process understanding
- Better control of sintering conditions
- Optimized crystallization behavior
- Enhanced material performance

Industrial Relevance

Thermal analysis measurements support:

- LTCC substrate development
- Electronic packaging materials
- Glass-ceramic manufacturing
- Low-temperature sintering technologies
- Advanced dielectric materials

Conclusion

The STA L81 measurements provide valuable insight into the crystallization kinetics of lead-free barium–zinc borosilicate glasses. Two distinct crystallization reactions were identified, corresponding to the formation of barium borate and barium zinc silicate phases. Understanding these thermal processes enables optimization of sintering profiles and supports the development of high-performance glass-ceramic materials for electronic applications.

Source:
Lopes, A.A.S., Monteiro, R.C.C., Soares, R.S., Lima, M.M.R.A., Fernandes, M.H.V.
Crystallization Kinetics of a Barium–Zinc Borosilicate Glass by a Non-Isothermal Method.
Journal of Alloys and Compounds 591 (2014), 268–274.
Adapted from differential thermal analysis measurements performed using a LINSEIS STA PT1600 (currently designated as STA L81).