Spatially Resolved Quantitative Mapping for Thermal Analysis Using Scanning Probe Microscopy

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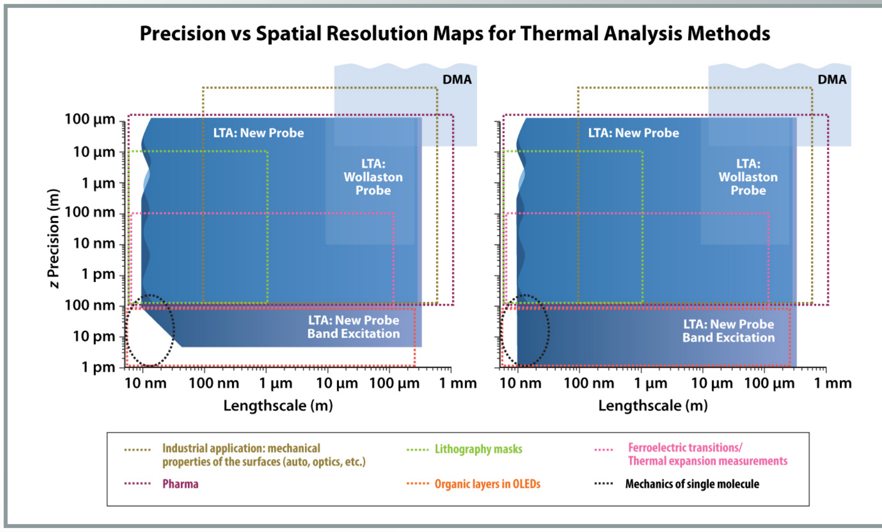

Technology Summary

ORNL researchers invented a method that uses band excitation acoustic force microscopy for quantitative mapping of polymeric materials. This technique probes thermomechanical properties and phase transition temperatures of materials at the nanometer scale. Data from this method are important for a variety of structural and functional materials, including composites, pharmaceuticals, and coatings.

Current approaches to local thermal analysis employ scanning probe microscopy but do not have the ability to detect dissipation of the sample material. The invention offers a means of calculating material loss. By including quantitative single point probing, spatially resolved mapping, and full temperature dependence, the method allows independent measurement of resonance frequency, Q factor, and oscillation amplitude of a tip surface contact. The researchers also developed a heating protocol that keeps the contact area and contact force constant, allowing for reproducible measurements of material properties.

In this method, samples of a polymeric material are mounted in a band excitation acoustic force microscope with a heatable cantilever tip. The tip is brought into contact with the surface of the material; it then undergoes a preliminary heating cycle followed by an analytical heating cycle. Data are collected from the analytical cycle to determine thermomechanical characteristics of the sample.

Advantages

- Moves beyond state-of-the-art local thermal analysis via scanning probe microscopy
- Detects dissipation of sample material
- Reproducible measurements

Potential Applications

- Characterization of thermomechanical properties in polymeric and other materials
- Characterization of the distribution of local transition temperatures, including melting and glass transitions
- Quality control methods for pharmaceutical coatings

Patent

Stephen Jesse and Sergei V. Kalinin, *Spatially Resolved Quantitative Mapping of Thermomechanical Properties and Phase Transition Temperatures Using Scanning Probe Microscopy*, application in process.

Inventors

Stephen Jesse and Sergei V. Kalinin
Center for Nanophase Materials Sciences
Oak Ridge National Laboratory

Licensing Contact

Jennifer Tonzello Caldwell
Group Leader, Technology Commercialization
UT-Battelle, LLC
Oak Ridge National Laboratory
Office Phone: 865.574.4180
E-mail: caldwelljt@ornl.gov

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