MEASURING INTERNAL FRICTION AT SONIC AND ULTRASONIC FREQUENCIES IN HIGH TEMPERATURE SUPERCONDUCTORS

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Internal friction measurements provide a sensitive means for probing some structural properties of materials. Defect relaxation processes and phase changes are frequently reflected in internal friction measurements as a function of temperature. Relaxation processes associated with oxygen content have been observed in YBCO and BSCCO (2212). By measuring the internal friction at different frequencies activation energies associated with relaxation processes can be determined. Structural changes are temperature dependent and independent of frequency.

To cover the widest range from megahertz to subsonic frequencies a variety of techniques are available. Most authors have usually concentrated on one method, however the present paper describes composite bar and flexural vibration methods covering the frequency range from 600 Hz to 120 kHz providing an adequate frequency range for activation energy determination.

The composite bar technique developed employs a piezoelectric quartz bar (with lengths of 2 cm or 3 cm and resonant frequencies of approximately 85 kHz or 120kHz) with a resonant bar of HTSC attached to one end. The quartz bar is suspended at its nodal points and the system excited electrically using a regenerative feedback system.

The composite bar method can also be used at low kilohertz frequencies by attaching the HTSC specimen used in the previous technique to the end of a much longer (eg 30 cm) fused silica rod which has very low damping. The resulting composite bar can be excited electrostatically or electromagnetically at frequencies below 10 kHz. The internal friction can be measured by scanning through the resonant frequency and measuring the bandwidth or by observing the decay of free oscillation in the bar. The advantage of using the two composite bar techniques is that the measurements can be made on the same specimen at different frequencies.

Flexural vibrations have been extensively used for measuring internal friction at low kilohertz frequencies. The advantage of this method is that small samples can be used (eg 10-30 mm x 5 mm x 0.3 mm) while overtone measurements provide coverage of a range of frequencies. Background damping due to suspension losses can be high using flexural methods, however the use of thin specimens and careful mounting can improve the situation.