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Ultrasonic attenuation and velocity investigation of sinter-forged superconducting $YBa_2Cu_3O_7$

M. Levy
University of Wisconsin - Milwaukee

B. K. Sarma
University of Wisconsin - Milwaukee

M.-F. Xu
University of Wisconsin - Milwaukee

Shireen Adenwalla
University of Nebraska-Lincoln, sadenwalla1@unl.edu

Z. Zhao
Northwestern University

See next page for additional authors

Authors
M. Levy, B. K. Sarma, M.-F. Xu, Shireen Adenwalla, Z. Zhao, Q. Robinson, and J. B. Ketterson

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phenomena are consistent with the suggestion that these ceramics are pseudoplastic solids in which the plasticity is attributed to the mobility of twin boundaries. Recent measurements of Bi–Ca–Sr–Cu–O superconductors will also be presented.

4:45–4:57
Break

Contributed Papers

4:57

JJ9. Ultrasonic studies of high-T_c superconductors. Yuuji Horie, Yuichiro Terashi, Hiroshi Fukuda, Masanori Hidaka, Takeshi Fukami, and Shoichi Mase (Department of Physics, Kyushu University, Fukuoka, 812 Japan)

High-T_c oxide superconductors [$MBa_2Cu_3O_7$ (M = Y and lanthanoids), $(La_{1-x}Sr_x)_2CuO_4$, $BaPb_{1-x}Bi_xO_3$, $x<0.35$] and their related insulating oxides [$MBa_2Cu_3O_6$, $BaPb_{1-x}Bi_xO_3$, $x>0.35$] were investigated by means of ultrasonic measurements. By using sound waves of $f_0 = 10$ MHz, we observed several peaks in the curves of the attenuation coefficient $\alpha(T)$ versus the temperature T for the superconducting samples. These peaks can be attributed to sound energy dissipation accompanied by excitations in optical phonons. However, there was no obvious anomaly near T_c except for $BaPb_{0.8}Bi_{0.2}O_3$ with $f_0 \sim 30$ MHz. The electronic contribution to $\alpha(T)$ was estimated to be very small in the Pippard mechanism of attenuation because of low electrical conductivity and a low f_0. In order to increase f_0, measurements with single-crystal samples having smaller resistivity are in progress. On the other hand, in the insulating samples, there are several peaks in the $\alpha(T)$ versus the T curves that can be assigned to some structural modulation. This assignment is supported by these piezoelectric and capacitance measurements. On the basis of these experimental results, the phonon contributions to high-T_c superconductivity are discussed.

5:09

JJ10. Ultrasonic attenuation and velocity investigation of sinter-forged superconducting $YBa_2Cu_3O_7$. M. Levy, B. K. Sarma, M.-F. Xu (Physics Department, University of Wisconsin—Milwaukee, Milwaukee, WI 53201), S. Adenwalla, Z. Zhao, Q. Robinson, and J. B. Ketterson (Physics and Astronomy, and MRC, Northwestern University, Evanston, IL 60208)

Sinter-forged $YBa_2Cu_3O_7$ exhibits rotational symmetry about the forging axis with the c axis of 80% of the crystallites aligned within 20° of the forging axis. Attenuation measurements as a function of temperature of longitudinal waves propagating perpendicular to the forging axis exhibit three broad relative maxima at 70, 180, and 250 K. Attenuation measurements with either longitudinal or transverse waves propagating along the forging axis exhibit only one maximum at about 180 K. The absence of the other two maxima along this orientation indicates that they could be produced by interaction mechanisms that may be associated with the Cu–O planes, while the 180-K maximum may be produced by an isotropic interaction mechanism. Sound velocity measurements show the sinter-forged material to be elastically anisotropic. The temperature dependence of the sound velocity shows distinct hysteresis curves that flatten out if the sample is not warmed above 250 K. Upon cooling, lattice softening is observed to start at temperatures much higher than T_c, and to stop below T_c. [Work supported by ONR at the University of Wisconsin—Milwaukee and by NSF at Northwestern University.]

5:21

JJ11. Can you hear the elastic tensor? William M. Visscher (Theoretical Division, MS B262, Los Alamos National Laboratory, Los Alamos, NM 89745)

The measured response of an object of known size and shape composed of a homogeneous but anisotropic elastic material as a function of frequency of excitation is, in principle, enough to determine the linear elastic constants, 21 of them in the most general case. A method for computing the resonant frequencies is explained and illustrated for an object of simple geometry ($a \times b \times c$ rectangular parallelepiped) with free or clamped faces of a material whose elastic modulus tensor reflects the symmetry of an orthorhombic lattice (nine independent constants). The method is a variant of MOOT [method of optimal truncation, see J. L. Opsal and W. M. Visscher, J. Appl. Phys. **58**, 1102 (1985)], which is a boundary residual method developed to compute elastic wave scattering. The calculation was undertaken as a part of the analysis of measurements of ultrasonic response of single-crystal, high-temperature superconductor materials (reported elsewhere at this meeting). Results will be presented, and the practicality of this approach to determine unknown elastic constants will be discussed. [Work supported by USDOE.]