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Focusing of fast transverse modes in silicon and slow transverse modes in zinc FREE

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Physical Acoustics: General I

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Contributed Papers

1:15

1pPA1. Determination of texture coefficients in hexagonal polycrystalline aggregates with orthorhombic symmetry using ultrasonic waves propagating on one to three principal planes. P. J. Kielczynski, A. Moreau, and J. F. Bussière (Industrial Mater. Inst., Natl. Res. Council of Canada, 75 De Mortagne Blvd., Boucherville, PQ J4B 6Y4, Canada)

A method to characterize the texture of hexagonal polycrystalline aggregates with orthorhombic macroscopic symmetry is presented. Previous methods are extended to the analysis of waves propagating on three principal planes of the material. Five coefficients of the crystallographic orientation distribution function, W_{200}, W_{220}, W_{400}, W_{420}, and W_{440}, are determined from angular variations of the phase velocity of the four ultrasonic modes considered: the bulk longitudinal waves, Rayleigh surface waves, the fundamental symmetric plate mode (in the long-wavelength limit), and shear-horizontal mode. Analytical expressions for the texture coefficients are found for an arbitrary number of principal planes. Measurements are reported for a Zr–2.5wt%Nb pressure tube, an alloy used in CANDU nuclear reactors. The angular variations of the phase velocity of leaky Rayleigh waves and leaky surface skimming compressional waves are measured with a line-focus acoustic microscope. The results agreed with neutron scattering measurements.

1:30

1pPA2. A comparison of elastic constants of the quasicrystalline and cubic approximant phases of AlCuLi, using resonant ultrasound spectroscopy. P. S. Spoor, M. J. McKenna, and J. D. Maynard (Dept. of Phys., Penn State Univ., University Park, PA 16802)

The anisotropy $\epsilon = |1 - 2c_{44}/(c_{11} - c_{12})|$ of a sample of quasicrystalline (T_2-phase) AlCuLi has been measured in our laboratory to be 0.0020 ± 0.0004; since a perfect quasicrystal should be isotropic, this could signify deviation from perfect icosahedral order. A comparison with the closely related R-phase cubic approximant, which is often present when macroscopic quasicrystals are grown, may provide a better basis for interpreting such measurements. Among the various methods of determining elastic properties, only resonant ultrasound spectroscopy, which uses the normal mode resonance frequencies to retreive the complete elastic tensor in one measurement, offers the necessary sensitivity to resolve such small anisotropies. Results on a recently received R-phase sample, and on its neighboring icosahedral grains, will be compared with the results mentioned above. [Work supported by NSF Grant No. DMR-9000549 and by the Office of Naval Research.]

1:45

1pPA3. Using piezoelectric film and resonant ultrasound for photoacoustic measurements of very low optical absorption in piezoelectric and dielectric crystals. M. J. McKenna, Wei-Li Lin, and J. D. Maynard (Dept. of Phys., Penn State Univ., University Park, PA 16802)

The photoacoustic effect is one of the most sensitive methods for measurements of the low optical absorption in glasses and crystals. Previously, a new photoacoustic technique has been developed, where a cw laser modulated at the acoustic resonant frequency of the sample generates an acoustic signal amplified by the quality factor of the resonance. With typical quality factors in the order of 10^5, this technique is several orders of magnitude more sensitive than conventional pulsed-laser techniques. However, previous applications using noncontact capactive transducers required precise postitioning of the sample, transducers, and seperate sample supports. Recently, this difficulty has been reduced through the use of 9-μm-thick piezoelectric (PVDF) film transducers. By supporting the sample at the corners between the film transducers, the need for separate supports is eliminated, with only a small reduction in the quality factor of the resonance. In addition, a large improvement in the signal-to-noise ratio is observed. Recent measurements on large single crystals of calcium floride and quartz will be discussed. [Work supported by NSF Grant No. DMR-9000549 and by the Office of Naval Research.]

2:00

1pPA4. Focusing of fast transverse modes in silicon and slow transverse modes in zinc. Kwang Yul Kim and Wolfgang Sachse (Dept. of Theoret. and Appl. Mech., Thurston Hall, Cornell Univ., Ithaca, NY 14853)

This paper presents focusing of fast transverse (FT) modes in silicon and slow transverse (ST) modes in zinc, both observed at utrasonic frequencies. Using a (001)-oriented silicon disk, the FT modes are generated and detected by two tiny shear PZT transducers, both polarized in the [100] direction. One transducer fixed on the bottom surface acts as a source and the other serves as a detector scanning the top surface along the [100] direction across various points on the [010] axis at some distances away from the epicenter. The observed focusing pattern indicates strong concentration of FT modes on the narrow band about the (100) plane containing the source. For a (001)-oriented zinc crystal, strong focusing of ST or quasi-transverse (QT) modes toward the symmetry direction is observed: first in theoretical and experimental, epicentral Green's functions; second with very small PZT source and PZT detector; finally with focused pulsed laser excitation and small PZT detector. The focusing patterns observed both in silicon and in zinc are consistent with the results predicted by the theory of phonon focusing. [Work supported by ONR.]

2:15

1pPA5. Characterizing the performance of acoustic microscopes. Leonard J. Bond and U. W. Lee (Dept. of Mech. Eng., Univ. of Colorado, Boulder, CO 80309-0427)

The transfer functions for focused and defocused, coherent and confocal imaging systems developed in optics are applied to the equivalent ultrasonic imaging systems. Assuming that both of the two systems are free of attenuation and aberrations except defocus, the ideal complex amplitude line-scan signals across a step edge, with various degrees of defocus, are generated. The scalar magnitude of ideal complex image