

Real Time Imaging and Analysis of Surface Acoustic Waves in TeO₂

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Surface phonon focusing in anisotropic materials has been studied by a wide variety of techniques[1-2], but real time imaging in two spatial dimensions has not been demonstrated effectively. Real time imaging of acoustic wave propagation allows the directional dependence of the energy propagation of acoustic waves in anisotropic materials to be better visualized and understood. Using an interferometric optical pump and probe technique, we have imaged the propagation of surface acoustic waves (SAW) at frequencies up to 1 GHz in real time, allowing movies of the SAW wavefronts to be made with picosecond temporal and micron spatial resolution[3]. Here we present results for TeO₂, and compare the observed wavefronts with theory.

The image in Fig.1 shows experimental data at a given moment in time for the surface displacement of the (100) surface of a single crystal TeO₂ substrate (tetragonal symmetry) coated with a Au thin film of thickness 60 nm. The SAW wavefronts, excited every 12 ns from a 2 μm diameter source, are elliptical. The white dots in Fig.1 represent the theoretical group velocity of the SAW (Rayleigh-like waves) ignoring the slight dispersion induced by the thin film, and the density of the dots represents the relative intensity as a function of angle. Fig. 2 shows the experimental and theoretical angular dependence directly. The elliptical wavefronts and the angular dependence of the SAW intensity demonstrate the expected phonon focusing effect owing to the substrate anisotropy. We have also made movies of the wavefront expansion for this and other orientations of the sample.

- [1] A. A. Kolomenskii and A. A. Maznev, Phys. Rev. B **48**, 14502 (1993).
[2] R. E. Vines, M. R. Hauser and J. P. Wolfe, Z. Phys. B **98**, 255 (1995).
[3] O. B. Wright, Y. Sugawara, V. E. Gusev and O. Matsuda (this conference).

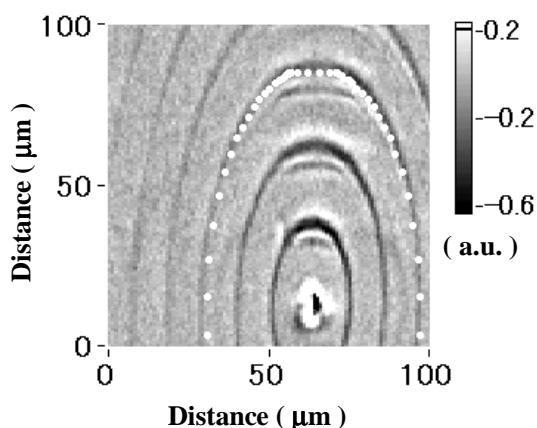


Fig. 1: Surface displacement snapshot of SAW wavefronts on the (100) surface of TeO₂ coated with a Au thin film (of thickness 60 nm). White dots: theoretical prediction based on a calculation of the group velocity.

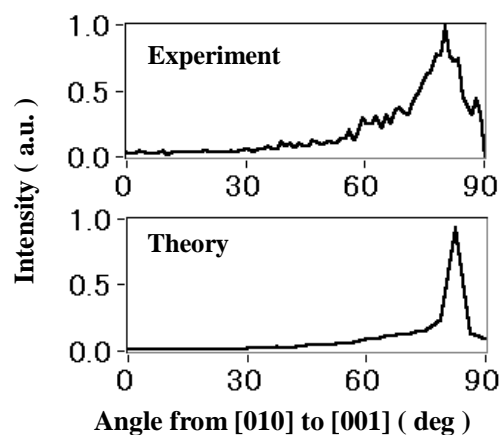


Fig. 2: Angular dependence of the SAW intensity calculated from the experimental data in Fig. 1, together with the theoretical prediction.