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Ballistic Phonon Propagation in Solid ^{4}He at Low Temperature[1]

YUKI AOKI, HARRY KOJIMA — Phonon propagations in hcp solid ^{4}He are being studied down to 30 mK including the recently discovered supersolid phase range. Phonons are generated with 2 μs long heat pulses by applying current into a metal film resistor (of area 5.2 mm^2) deposited onto a planar silicon substrate. The power applied to the heater is varied between 20 and 200 μW/mm^2. The phonons travel through 4.3 mm of solid ^{4}He and are detected by superconducting edge sensor of 60 nm thick titanium film. In agreement with earlier studies, the main propagation peak detected by the sensor is the transverse sound propagation. Crossover from second sound in normal solid to ballistic propagation is observed between 100 mK and 300 mK at 25 bars. Measurements of ballistic phonon propagation are extended up to 50 bars for the first time. The velocity of transverse phonon propagation increases from 220 m/s at 25 bars to 250 m/s at 50 bars. It is expected that supersolid transition modifies the velocity of transverse sound propagation. It is found, within $\pm$1.5 % scatter of data, the ballistic phonon propagation velocity(measured at 200 μW/mm^2) remains constant below 100 mK at both 25 and 50 bars. At 30 mK, the velocity is independent of heater power within $\pm$1 %.

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