	Experiment title: Dynamic structure factors of liquid Sn and Pb	Experiment number: HS-1648
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Report:

Due to low coordination numbers and characteristic shapes in total structure factors $S(Q)$, liquid (l-) Si and Ge are widely believed that covalent bonding like the solid states coexists with metallic bonding. Our recent inelastic x-ray scattering (IXS) experiments on l-Si [1] and Ge [2] give clear indications for propagating phonon modes, and the latter do not show any *positive* dispersion as found in several hard-sphere liquid metals such as l-alkalis [3]. The heavier 4B element Sn has an intermediate feature in the liquid structure between Ge and alkali metals. From the experiment on l-Sn, we expect to obtain hints for the origin of the *positive* dispersion.

The IXS experiments on liquid Sn were carried out in transmission mode using high-energy x-rays of 17.794 keV (Si(999)) to obtain the high energy resolution (~2.88 meV FWHM) necessary for investigating the phonon dynamics in this liquid. High temperatures up to 1000 °C were achieved using an internally heated vessel equipped with a continuous Be windows covering a scattering angle range of 0-25°. The Sn sample was contained in a single-crystal sapphire cell with a wall thickness of 0.25 mm, which is highly transparent to hard x-rays and produces almost no inelastic contribution in the ω range of interest. We measured $S(Q,\omega)$s at twenty Q positions from 2 to about 30 nm^{-1} at two temperatures: 320 and 1000 °C. A resolution correction was performed by fitting the convolution of a model function and the experimentally obtained resolution function to the experimental data. As the model function, a Lorenzian was chosen for the central line and a damped harmonic oscillator for the inelastic peaks.

Fig. 1 shows the results of $S(Q,\omega)$ at 320 °C normalised to $S(Q)$. Full circles represent the experimental data with error bars, and the solid lines are the best fits of the convolution integral to the data. The experimental resolution function is also given by a dashed line. In the low Q range, distinct phonon peaks superimpose the quasielastic lines. With increasing Q, the inelastic peak position increases up to around $Q = 13$ nm^{-1} and then decreases. The width of both the inelastic peaks broadens with Q indicating strong damping. The spectra in Fig. 1 demonstrate that the dynamics of *l*-Sn is dominated by longitudinal propagating modes, similar as in *l*-alkali metals, Si, and Ge.

The phonon excitation energy ω_Q and the width Γ_Q are plotted in Fig. 2 by circles and triangles, respectively. The dashed line represents the dispersion of hydrodynamic sound obtained from a recent measurement of the adiabatic sound velocity (2443 m/s) [4]. The ω_Q values lie on higher energies than the hydrodynamic line in the low Q region. Namely, the so-called *positive* dispersion relation observed in *l*-alkalis is also found in *l*-Sn, which contrasts with the results in *l*-Ge. Very similar results are also obtained at high temperature of 1000 °C. Further analyses using extended hydrodynamics theory are now in progress.

[1] S. Hosokawa *et al.,* ESRF Report HS-1504; Nucl. Instrum. Methods B, submitted.
[2] S. Hosokawa *et al.,* Phys. Rev. B **63**, 134205 (2001); Physica B, in press.
[3] W.-C. Pilgrim *et al.,* J. Non-Cryst. Solids **250-252**, 96 (1999), and references therein.
[4] N. Yoshimoto *et al.,* Jpn. J. Appl. Phys. **35**, 2754 (1996).

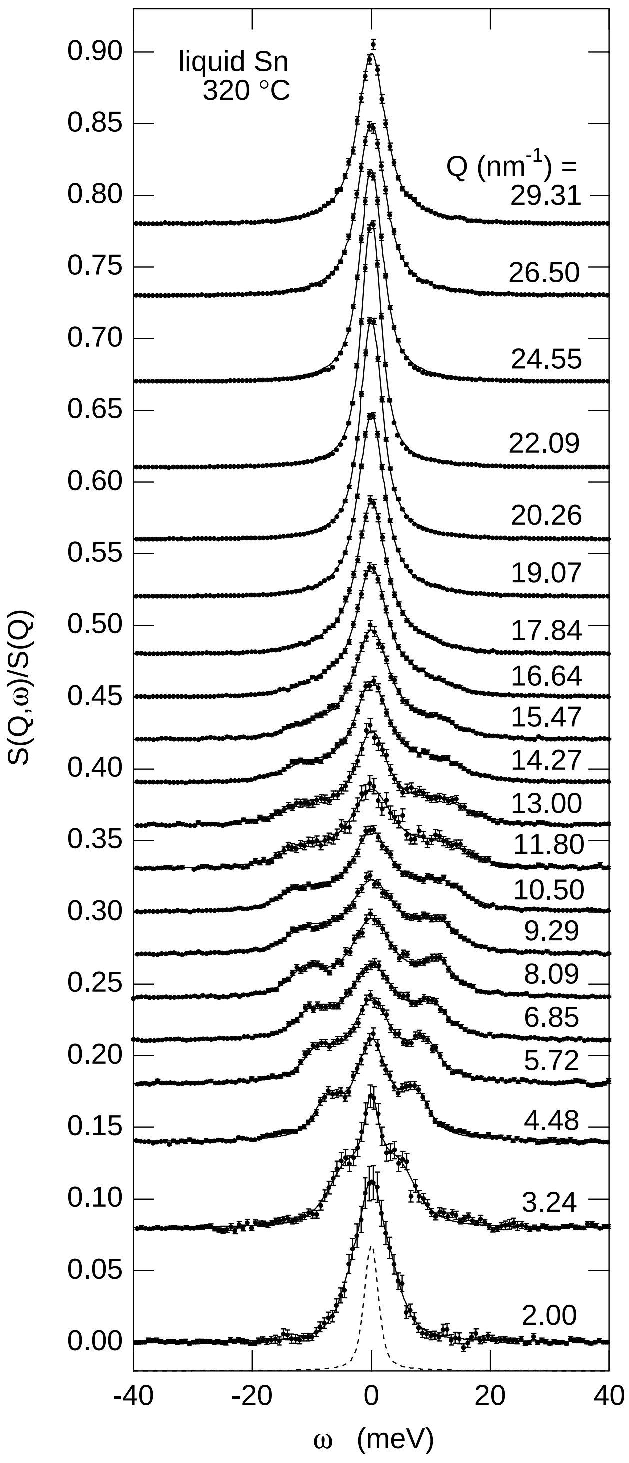

Fig. 1

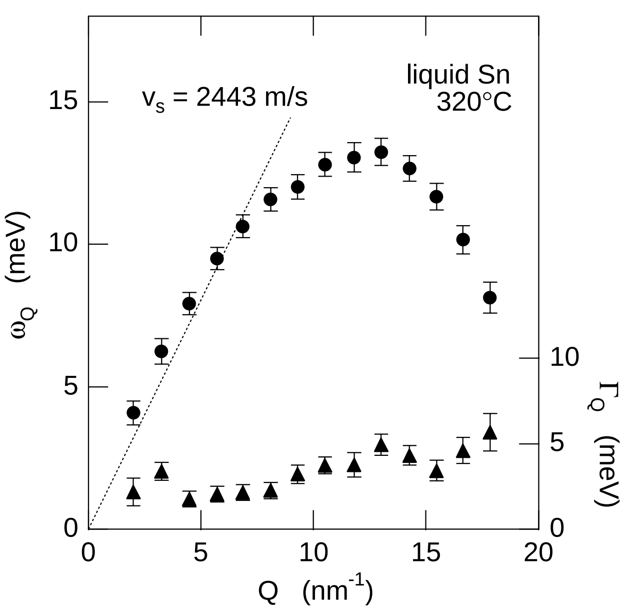

Fig. 2