Time-resolved x-ray scattering from laser-molten InSb

R. Nüske, C. von Korff Schmising, A. Jurgilaitis, H. Enquist, H. Navirian,
P. Sondhauss and J. Larsson
Atomic Physics Division, Department of Physics, Lund University, P.O. Box 118, SE-221 00 Lund, Sweden

We demonstrate a concept to study transient liquids with picosecond time-resolved x-ray scattering in a high-repetition-rate configuration. Femtosecond laser excitation of crystalline indium antimonide (InSb) induces ultrafast melting, which leads to a loss of the long-range order. The remaining local correlations of the liquid result in broad x-ray diffraction rings, which are measured as a function of delay time. After two nanoseconds the liquid structure factor shows close agreement with that of equilibrated liquid InSb. The measured decay of the liquid scattering intensity corresponds to the re-solidification rate of 1 m/s in InSb.

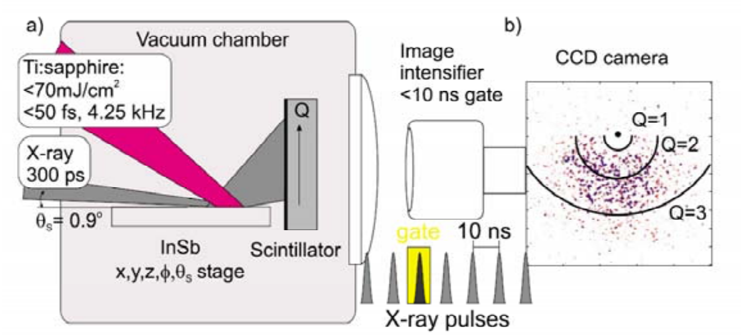

Figure 1: a) The scattering pattern is detected b a plastic scintillator. An image intensifier gates single x-ray bunches to achieve a time resolution limited by the x-ray bunch length b) A typical 2D image of the liquid structure factor at t = 2 ns;.

The main feature at Q=2.2 A^{-1} has been attributed to the In-Sb bonds, whereas the second feature at Q=3.0 A^{-1} depends on Sb-Sb bonds.

As can be seen in the inset in figure 3, the two features (squares and triangles) have the same temporal dependence showing that these coordination distances are inherent to the liquid.

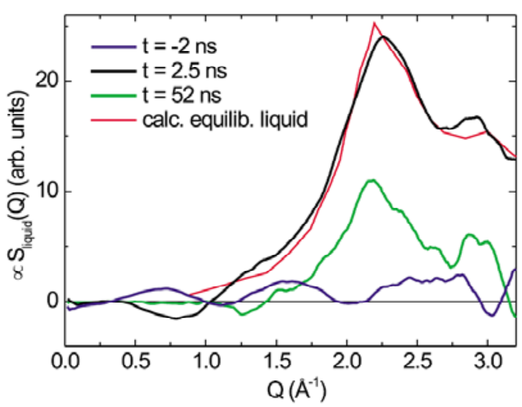

Figure 2: Liquid structure factor S(Q) at at various time delays: -2 ns, +2.5 ns, and 52 ns in respect to the laser pulse.

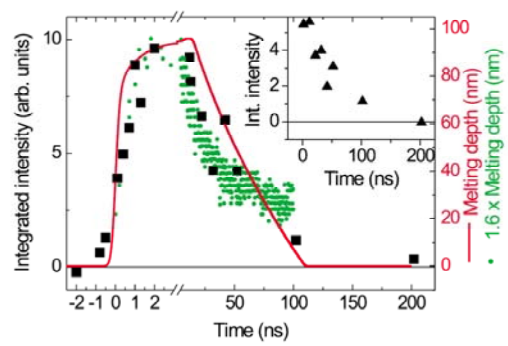

Figure 3 Integrated structure factor S(Q) as a function of time. The melting depth (solid line) as calculated using a 1D heat flow equation matches the experimental data.

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