	Experiment title: Laser shock compression of pre-heated Bi, Sb, Sn	**Experiment number**: HC3440
Beamline: ID09	**Date of experiment**: from: 26/01/2018 to: 30/01/2018	**Date of report**: 21/02/2018
Shifts: 12	**Local contact(s)**: Norman Kretzschmar	*Received at ESRF:*

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Report:

Scientific background

X-ray diffraction coupled with dynamic compression of matter induced by laser is an ideal technique to acquire information on the kinetics mechanims and path of compression-induced structural transitions, nucleation processes and texturization. The capabilities of ID09 at ESRF are ideally suited (an integrated laser featuring 5 ns pluses of 350 mJ and an X-ray flux of $4x10^8$ ph/pulse) for the study of low-pressure phase diagrams like Bi, Sn and Ti for instance. These three elements present a very rich low-pressure phase diagram, exhibiting numerous solid-solid phase transitions below or around 10 GPa. Moreover, both Bi and Sn possess low temperature melting curves at these pressures. The use of 500K pre-heated targets would then make it possible to cross a solid-liquid or liquid-solid phase transition.

Experimental technique

A confined geometry design for the target allows to achieve a stable warm and dense state of a 2-3ns lifetime and then to probe the shock release. Combined with a small furnace of our design that can bring the target up to 600°C, this experimental configuration offers the possiblity to explore a large P-T space below 10 GPa and 600 K. X-ray diffraction is performed at various delays, typically between -1 ns and +25 ns relatively to the arrival of the laser on the target with time steps of 0.5 ns, allowing us to get information on the phase

transitions, the kinetics and the whole recrystallization process. Very good reproducibility of the shock state has been observed.
A VISAR (Velocity Interferometer System for Any Reflector) had been installed on the beamline in order to measure the shock velocity at the back surface of the targets thus allowing us to deduce the maximum pressure induced in the sample.

Results

Four different types of targets were tested, as follow:

- Polycarbonate / Sample / Polycarbonate
- Glass / Sample / Polycarbonate
- Saphir / Sample / Polycarbonate
- Saphir / Sample / LiF

Bismuth targets were shocked with a starting temperature of 300 and 420 K.
Tin targets were shocked with a starting temperature of 300 and 450 K.
Titanium target were only shocked at ambient temperature.
Around 1050 x-ray diffraction images have been collected and are now being analyzed.

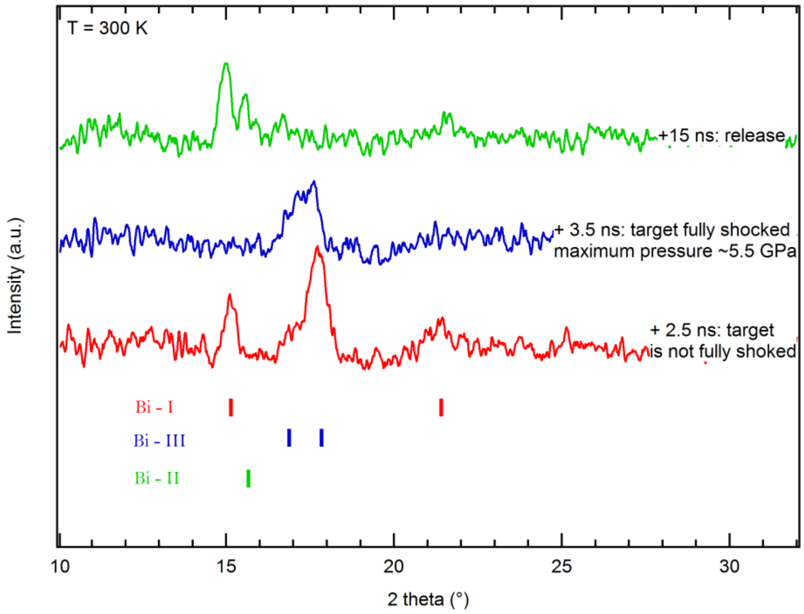

Figure 1: Diffractograms showing an example of a phase transitions sequence observed in Bi with a starting temperature of 300K

The sequence of phase transitions I → III → II → I was observed in bismuth for a starting temperature of 300K (see fig 1) and I → IV → II → I for a starting temperature of 420 K.
Complementing results obtained during a previous run (report HC-879), a drastic change of texture was observed in tin when crossing the transition line beta – bct tin, as shown in figure 2 for a starting temperature of 450 K.

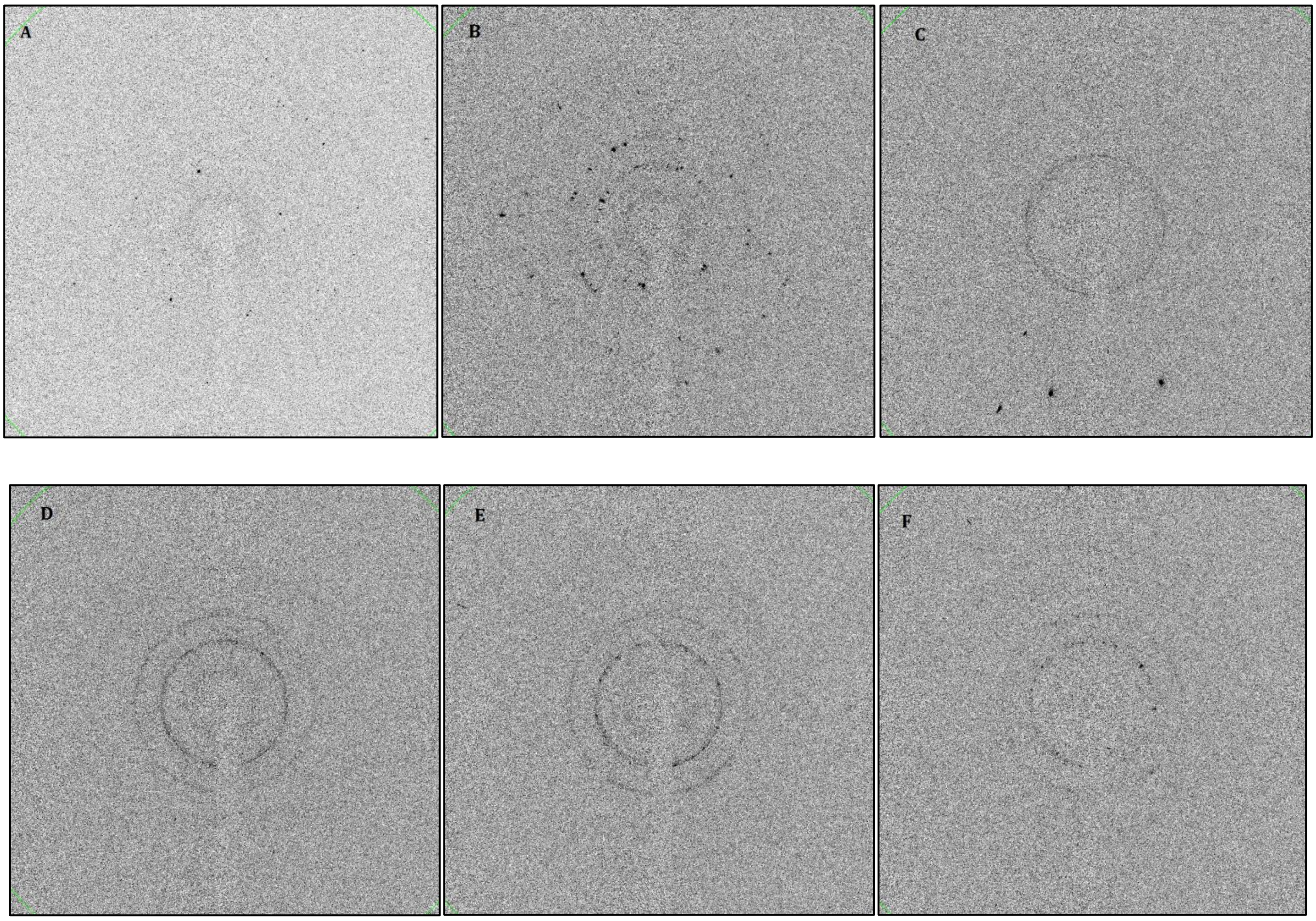

Figure 2: Example of image plates collected on shocked Sn with a starting temperature of 450 K

A: starting material, highly oriented beta-Sn, large crystals, B: +1.5ns, texturization, gradual loss of orientation, C: +3.5ns, transition to bct-Sn, powder (bright spots come from the LiF backside window), D: +10ns, release, reappearance of beta-Sn, powder, E: +16ns, start of recrystallization, F: +25ns, much less powdery