ESRF	**Experiment title:** Measurement of the Phonon Density of State in Sn-metal to 1 Mbar	**Experiment number**: HS-3168
Beamline: ID22N	**Date of experiment**: from: 04.10.06 to: 10.10.06	**Date of report**: 23.07.2007
Shifts: 19	**Local contact(s)**: Dr. Ulrich Ponkratz	*Received at ESRF:*

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Report:

The goal of this beamtime was to study the phonon DOS of Sn around the two phase transitions (10 and 45 GPa). During this beamtime we achieved good data at pressures of 6.4 and 17.9 GPa. Higher pressures also could not be achieved due to the soft gasket material. The gasket material, Beryllium (Be), came from a shipment with a high purity of Be and not from a Be-BeO sample thus it could not withstand the force of the diamonds and the sample often floated out.

Metallic tin enriched to 93% in ^{119}Sn was used in the NRIXS experiments. At ambient conditions the NRIXS spectrum was recorded with the β-Sn metal piece prepared between two adhesive tapes, which were than placed between two avalanche photodiode (APD) detectors. The high pressure NRIXS experiments were executed with a Paderborn-type diamond anvil cell (DAC) [1]. At all pressure metallic Sn was loaded into a Be-gasket. A 4:1 methanol-ethanol mixture was used as a pressure transmitting medium and some spherical ruby crystals were used for pressure determination [2] in the high pressure laboratory of beamline ID18.

The NRIXS experiments on Sn were performed at the beamline ID22N with the use of a LN2-cooled Si(1,1,1) double-crystal premonochromator and a high-resolution monochromator (HRM) consisting of two pairs of ("nested") Si(12,12,12) and Si(6,4,2) crystals [3]. The focusing optics consisted of a Kirckpatrick-Baez mirror behind the HRM, in the experimental hutch. The monochromized beam was focused on a spot of 21×19 μm (h×v). For the detection of the inelastic Sn radiation two avalanche photo diodes were used.

Fig. 1 shows typical spectra of Sn at ambient pressure up to the highest pressure of 17.9 GPa. The phase transition effects are clearly evident and pronounced by looking at the spreading of the phonon side wings with increasing pressure.

A preliminary evaluation of the data yield clear evidence for an increasing of the Lamb-Mössbauer factor at increasing pressures. We were able to extract for the first time the phonon DOS directly from the inelastic scattered signal at room temperature for the higher

pressures. Due to the overwhelming multiphonon contribution at ambient pressure the DOS could not be extracted.

The Sn site of $FeSn_2$, FeSn, Fe_3Sn, Fe_5Sn_3 at ambient pressure was also measured to complement previous measurements of the Fe site. Fig. 2 shows both partial phonon DOS of $FeSn_2$ at ambient condition.

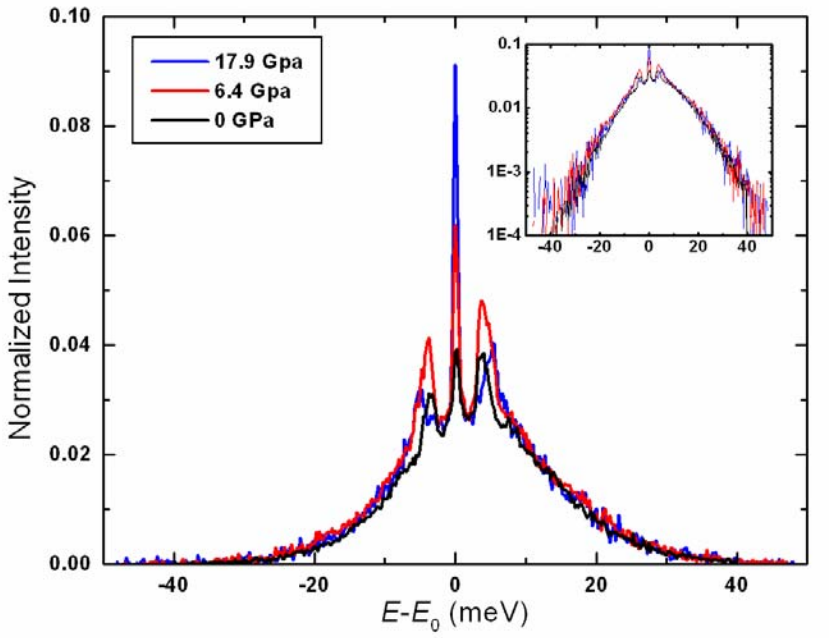

Fig. 1: *Phonon NRIXS spectra for pressures achieved*

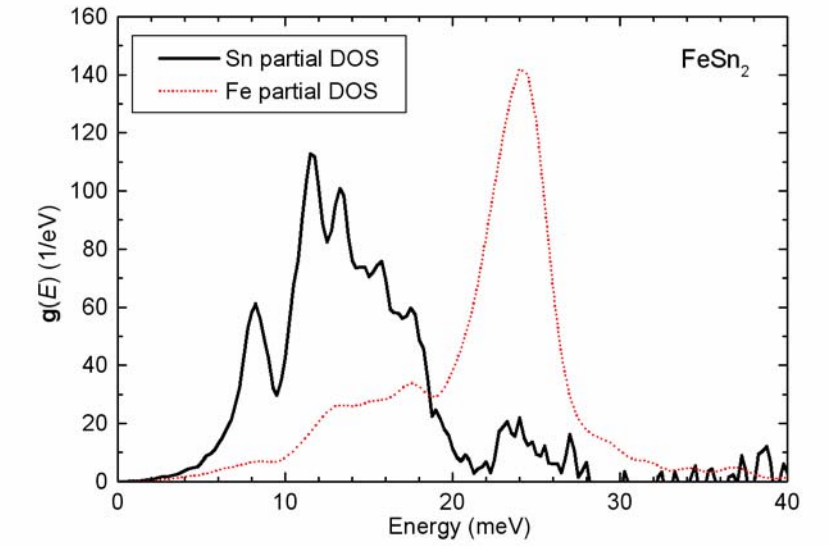

Fig. 2: *Partial phonon DOS of $FeSn_2$ at the Fe and at the Sn site at ambient conditions. The Sn site was measured at the ESRF and the Fe site at the APS beamline 16ID-D [4].*

References:
[1] H. Giefers et al., High Pressure Research 22, 501 (2002).
[2] H.K. Mao, J. Xu, P.M. Bell, J. Geophys. Res. 91, 4673 (1986).
[3] A.Barla et al., Phys. Rev. B 61, R14881 (2000).
[4] H. Giefers, M. Pravica, M. Nicol, M.Y. Hu, unpublished results.