	Experiment title: Acoustic phonon dispersion in cobalt under high pressure	**Experiment number**: HS-1638
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Report:

The longitudinal acoustic (LA) phonon dispersion along the [100] direction (a-axis) in a single crystal of Cobalt has been determined as a function of pressure up to 9.5 GPa at room temperature. The sample of 70 μm diameter and 15-20 μm thickness was loaded in a 450 μm diameter hole drilled in an Rhenium gasket, pre-indented to 60 μm (initially 200 μm), and pressurized in a diamond anvil cell (DAC) (700 μm culets) with helium as pressure transmitting medium. The pressure was determined *in situ* by conventional ruby fluorescence technique, and cross-checked by the determination of the lattice parameter a by x-ray diffraction, making use of the known equation of state of cobalt [1]. The crystal was aligned such a way that the [100] and [001] reciprocal lattice directions lay in the horizontal scattering plane. The experiment was performed with an overall energy resolution of 3 meV and a momentum resolution of 0.3 nm^{-1}. Spectra were recorded at typically seven different reduced momentum transfers, q, using two settings of the spectrometer (recording 3 and 4 inelastic scattering spectra simultaneously).

The LA wave velocity along the [100] direction was obtained by a sine function fit to the dispersion curve:

$$E\,[\mathrm{meV}] = 4.192\times10^{-4}\, V_{p[100]}[\mathrm{m/s}] \times q_{Max}[\mathrm{nm}^{-1}]\, \sin\{\pi/2\times(q[\mathrm{nm}^{-1}]/q_{Max}[\mathrm{nm}^{-1}]\}$$

where q_{Max} is the value of q corresponding to the Brillouin zone boundary where the slope of the dispersion is zero. This parameter was experimentally determined for each pressure and fixed in the fitting procedure. This procedure allowed us to obtain sound velocities with an error significantly lower then the one obtained by a direct determination from a single low q data point.

The elastic constant C_{11} is then obtained by the relation $C_{11} = \rho \times V^2_{p[100]}$, where the density is calculated from the cobalt EOS [1].

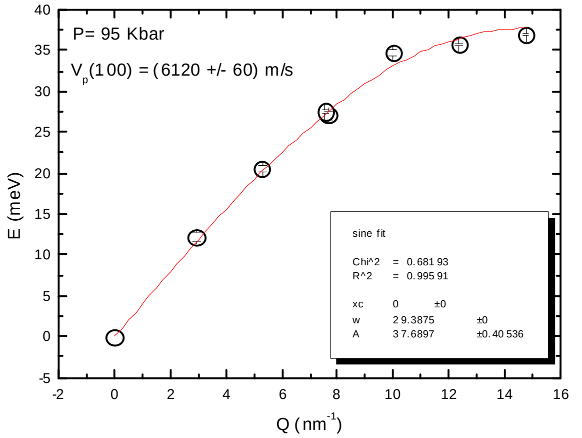

Figure 1 shows, as an example, the LA phonon dispersion curve obtained at 9.5 GPa with the best sine fit. The derived sound velocity is indicated as well.

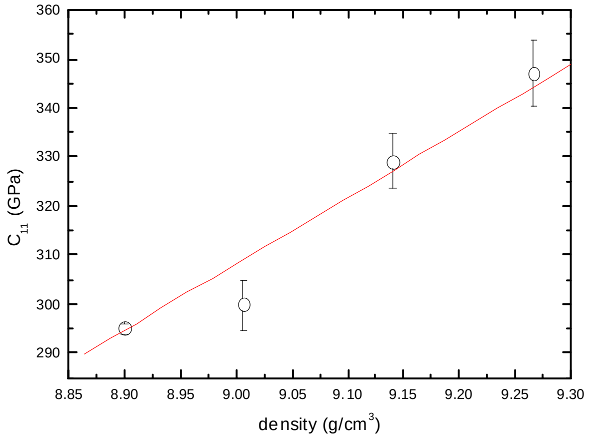

Figure 2 shows the behaviour of C_{11} as a function of pressure. A least-squares linear regression is shown (solid line). Room pressure data are from ref. [2].

These first results demonstrate that such an experiment is feasible, and that elastic constants and their pressure-induced variations can be determined with high precision by IXS. As shown in Fig. 2, the variation of C_{11} with pressure is almost linear in this pressure range.

Future experiments should extend this study to higher pressures and to different directions in order to obtain all five elastic constants (C_{11}, C_{33}, C_{44}, C_{12}, C_{13}) as a function of pressure.

References

[1] H. Fujihisa and K. Takemura, Phys. Rev. B 54, 5 (1996)
[2] R. F. S. Hearmon, *The Elastic Constant of Crystals and Other Anisotropic Materials* in Landolt Börnstein, New Series III, Vol. 11 (Springer, Berlin, 1979)