ESRF	**Experiment title:** Are there crystal-like high frequency phonons in the amorphous tetrahedral semiconductor a–Si?	**Experiment number:** HS1317
Beamline: ID28	**Date of experiment:** from: 04/11/2000 to: 12/11/2000	**Date of report:**
Shifts: 21	**Local contact(s):** M.Krisch, A.Mermet, H.Requardt	*Received at ESRF:*

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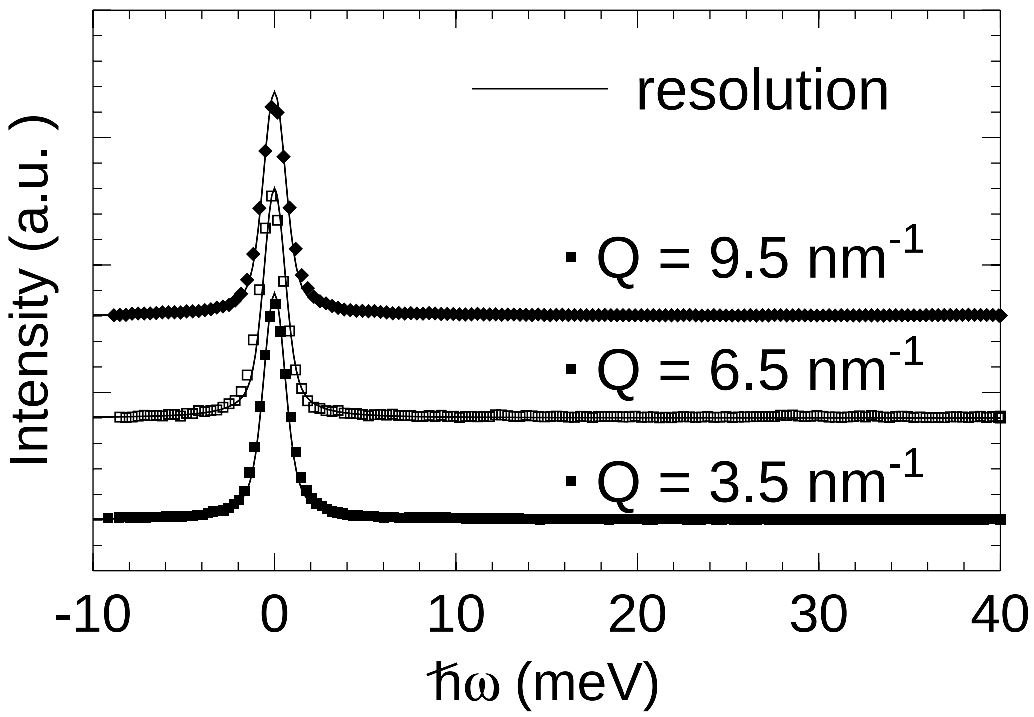
Report:

Throughout recent years a perception has been found on some dynamic properties of disordered, amorphous or glassy solids. As general dynamic features of these systems tunnelling modes at very low temperatures ($T < 1$ K), an excess of vibrational modes, Boson–peak, in comparison to the crystalline counterparts at energies of some meV and a strong damping of collective excitations at $Q \sim \text{nm}^{-1}$ and $\hbar\omega \sim$ meV are detected [1,2,3]. Moreover, following the standard classification of glasses [4] a correlation between the fragility of the glassy systems and the intensity of the Boson–peak and the strength of the damping of collective modes is found. Here, the stronger a glass is the stronger is its Boson–peak and the mode damping [2,3].

However, based on experimental results indicating that in the 'strong' glassy Silicon tunnelling modes are absent [5] and that the supposed 'strong', amorphous solid water does not exhibit a strong damping of collective vibrations [6] a new type of glasses is proposed, namely the so called super–strong glass [7]. The characteristic property of the super–strong glasses should be a 'strong' behaviour of viscosity but a complete loss of properties associated with strong glasses, i.e. tunnelling modes, Boson–peak and mode damping.

To test the super–strong hypothesis we performed a high–resolution inelastic x–ray scattering experiment on amorphous Silicon to study the properties of collective excitations and to determine their damping behaviour in particular. We utilised the beamline ID28 in very high-resolution mode $|DeltaE \approx 1.5$ meV with an incoming Energy of 21.7 keV. Constant momentum scans were performed at $Q = 2.0, 3.5, 5.0, 6.5, 8.0, 9.5, 11.012.5, 14.0, 15.5$ nm^{-1}. The scanned energy range was adapted to the momentum range according to the well known dispersion relation of phonons in crystalline Silicon. All measurements are done at room temperature.

As it can be judged from the selected set of scans shown in the figure below all obtained spectra are dominated by the strong elastic line, reminiscent of the disorder of the α–Si sample. This elastic contribution obscures the signal to such a degree that a presence of inelastic modes can not be established by numerical techniques. The current quality, i.e. statistics of data does not allow to interprete the results in terms of collective excitations.



[1] R.C.Zeller at al., *Phys. Rev. B*, **4**, 2029, (1971).
[2] A.P.Sokolov et al., *Phys. Rev. Lett.*, **78**, 2405, (1997).
[3] F.Sette et al., *Science*, **280**, 1550, (1998).
[4] C.A.Angell et al, *Il Nuovo Cimento*, **16**, 993, (1994).
[5] J.L.Feldman et al., *Phys. Rev. B*, 3551, (1999).
[6] H.Schober et al. *Phys. Rev. Lett.* **85**, 4100, (2000).
[7] C.A.Angell et al., *Phys. Chem. Chem. Phys.*, **2000**, 1559, (2000).