Experiment Report Form

ESRF	**Experiment title:** **Energy landscape and THz dynamics of a hyperaged geological glass**	**Experiment number**: HC 1933
Beamline: ID28	**Date of experiment**: from: July 8th, 2015 to: July 14th, 2015	**Date of report**: September 10th 2015 *Received at ESRF:*
Shifts: 18	**Local contact(s)**: A. Bosak	

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Report:

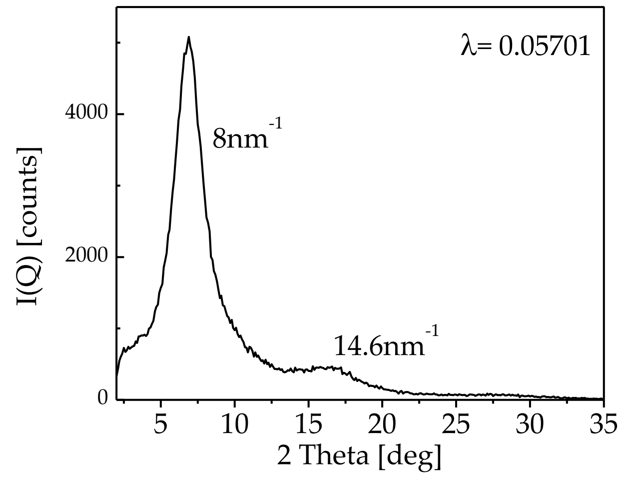
Fossil amber is a chemical glass, resulting from the solidification of liquid resin into glassy state accompained by polymerization of dienic functions and evaporation of volatile components. Its glass transition temperature is only few tens of degree above room temperature, thus during the natural million-years ageing it experiences, it can spontaneously anneal into an extremelly low-enthalpy state, endowed with unparalleled high degree of thermodynamical stability. This material represents a unique opportunity for investigating the properties of glassy state approaching the limit of the ideal glass, i.e. the bottom of configurational energy landscape. Rejuvination can be obtained by thermal annealing amber into supercooled liquid phase. Pristine amber shows an higher density and higher longitudinal sound velocity in the GHz regime once compared to rejuvinated sample[1].

The aim of the proposal was to investigate the vibrational modes dispersions in the THz frequency range. **We report here inelastic x-ray scattering (IXS) measurements of the acoustic phonon dispersion of pristine and rejuvenated amber.** The thermodynamical stability of the sample before and after the rejuvenation has been checked with DSC scan testifying for their very different stability degrees. We succeeded **in measuring a sizable portion of the pseudo Brillouin zone of longitudinal acoustic phonons** up to wavevectors Q=3.5 nm^{-1}. At higher Q values coherent oscillations cannot be distinguished anymore due to the stronger contribution of the elastic line to the spectra upon approaching the position of the first peak in the static structure factor (see Fig1.A). We **demonstrate that amber can support dispersive excitations** in the THz range and that the **mode stiffening of the hyperaged glass** relative to the GHz range **persists at the mesoscopic limit** (see Fig.1B).

Having ascertained the presence of propagating modes up to 5.5 meV, we would like for future experiments to measure the vibrational density of state in the same energy region.

References

[1] Pérez-Castañeda, T., Jiménez-Riobóo, R. J. and Ramos, M. A *J. Phys.: Condens. Matter* 25, 295402 (2013).



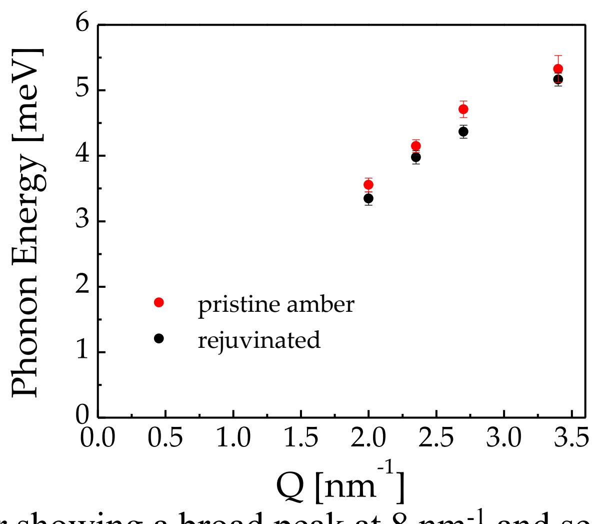


Fig. 1 A) Static structure factor of pristine amber showing a broad peak at 8 nm^{-1} and second peak at 14.6 nm^{-1}. B) Longitudinal acoustic phonon dispersion of pristine (red dot) and rejuvinated (black dots) amber.