ESRF	**Experiment title:** **The Structural relaxation process close to the dynamic anomaly in the glass transition region of ortho-Terphenyl**	**Experiment number:** SC-4358
Beamline: ID18	**Date of experiment:** from: 24/05/2017 to: 31/05/2017	**Date of report:** 10/09/2017
Shifts: 18	**Local contact(s):** Aleksandr Chumakov	*Received at ESRF:*

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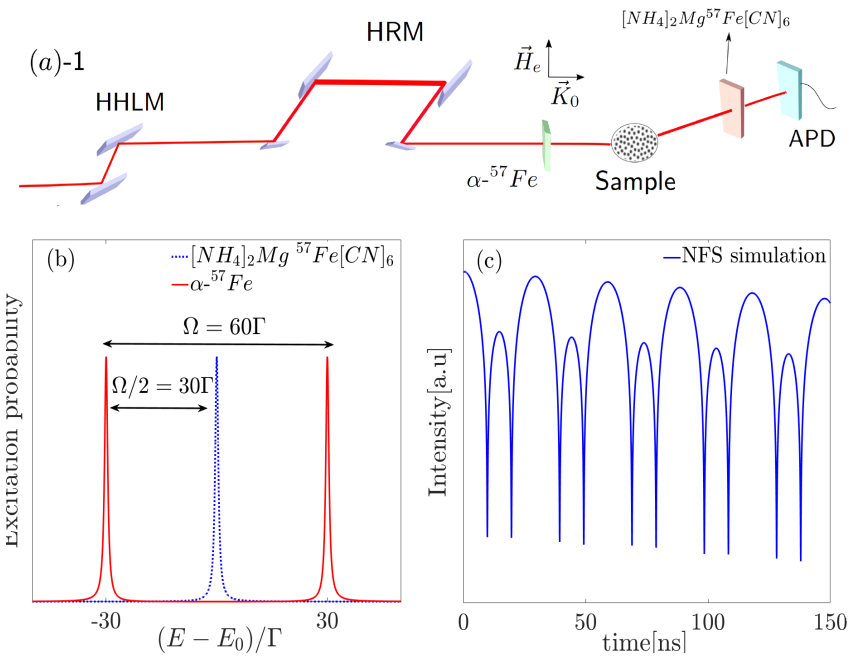
Report:

Nuclear gamma-resonance time domain interferometry (TDIis one of the most promising techniques for studying the slow dynamics of glasses at the microscopic length scale [1].

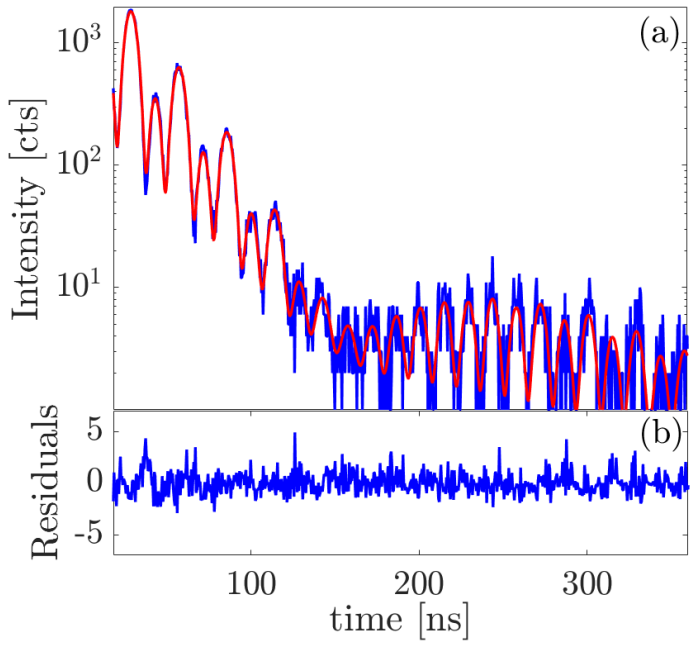


In γ-nuclear resonance time domain interferometry [1] two nuclear absorbers containing 57Fe nuclei are placed upstream and downstream of the sample with slightly different nuclear excitation energies achieved by mounting the first absorber on a velocity transducer. These absorbers are used to generate both probe and reference gamma rays from the first excited state of 57Fe. Then, the interference beating pattern of these gamma rays is detected in the time domain. The beating pattern is modulated by the relaxations of the density correlation, and in this way the intermediate scattering function is probed. Our measurments have been performed using new experimental scheme for TDI[1] implemented and fully characterized during this beamtime. Differently from the typical TDI set-up, a two line nuclear absorber, a magnetized α-Fe foil, was used to provide the reference beam of the time domain interferometry [2]. A skematic representation of the apparatus is reported in fig.1-(a). fig.1-(b) reports the energy spectrum of the interferometer whereas fig.1-(c) shows the simulated beating pattern for the set-up. In this case the reference beam from the α-Fe absorber has a two-lines energy spectrum and two grups of quantum beats can be observed.

This new configuration allows to obtain beating patterns with good contrast and statistical accuracy up to 350ns, also avoiding the blurring of quantum beats due to the additional vibrations introduced by the imperfect motion of the velocity transducer [2].
The data obtained from the new propose scheme can be fitted using the equation reported below[2]:

$$I(t,q) \propto 2|G(t,T_\alpha)|^2 + |G(t,T_S)\cdot F_D(t,\Gamma_D)|^2 + 4Re\{G(t,T_\alpha)G^*(t,T_S)\}\cdot F_D(t,\Gamma_D)\cdot$$
$$+2\cos(\Omega t)|G(T_\alpha,t)|^2 .\ \cos\left(\frac{\Omega}{2}t\right)\cdot\cos(\omega_{IS}\cdot t)\cdot\phi(\mathbf{q},t)$$

Here $G(t,T_\alpha)$ and $G(t,T_S)$ are the response functions of the upstream and downstram absorbers of effective thickness T_α and T_S respectively. Ω is the distance in frequency between the two lines of the α-Fe foil whereas ω_{IS} is the isomer shift frequency for the downstream absorber. Finally $\Phi(\mathbf{q},t)$ is the normalized intermediate scattering function of the system and $F_D(t,\Gamma_D)$ is a function describing the instrumental damping of quantum beats due to inhomogeneous broadening of the spectral lines of the nuclear absorbers Γ_D.



During the measurments, the OTP sample crystallized several times complicating the collection of the experimental data.
Nevertheless quasi-elastic scattering from OTP at several temperature and exchanged wave-vectors were collected. Data are still under processing. Fig.2-(a) reports an example of the measured beating patterns along with the curve obtained from the fitting procedure. In particular the shown data were measured at a temperature of 276.4K and for an exchanged wave-vector q=14nm^{-1}, that is at the maximum of the static structure factor of the OTP. Fig.2(b) shows instead the residuals of the fitting procedure. The chi-square of the fitting procedure along with the extracted mean relaxation time $<\tau>$ and non ergoditicy factor f_q are listed in the table below.

χ^2_{red}	f_q	$\langle\tau\rangle$ [s]
1.06	0.78(2)	$5(3)\times10^{-6}$

This obtained relaxation time with the one from [3] and [4].
In the next months the data processing will continue in order to extract all the parameters of the studied relaxation processes, but on the basis of the present and previous results a first paper has already been completed [2].

References:

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