ESRF	**Experiment title:** Study of the transient structure of sliding charge-density-waves in $NbSe_3$	**Experiment number**: HS1577
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Shifts: 31	**Local contact(s)**: Gerhard Grübel	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

A. Ayari, CRTBT-CNRS, Grenoble *
R. Currat, ILL, Grenoble
R. Danneau, ILL *
E. Lorenzo, Cristallographie-CNRS / ESRF, Grenoble *
P. Monceau, CRTBT-CNRS *
L. Ortega, Cristallographie-CNRS *
H. Requardt, ESRF, Grenoble *

Report:

A number of quasi-one-dimensional metals, such as $NbSe_3$, are known to undergo a so-called Peierls transition into a low-temperature state with modulated electron density, the charge-density-wave (CDW). The periodic lattice distortion accompanying the CDW gives rise to satellite reflections observable with e.g. X-ray diffraction techniques. In real crystals the CDW is pinned to the parent lattice by impurities but can be depinned when applying a current exceeding a threshold value. The depinned, sliding CDW leads to an extra charge transport channel which requires conversion between the applied normal (quasi-particle) current and the condensed (CDW-) current. The current conversion gives rise to a spatially dependent deformation of the CDW between the current contacts. This deformation has been studied experimentally on the upper CDW-phase of $NbSe_3$ ($T_{Peierls1} = 145K$ with $Q_{CDW1} = (0, 1.241, 0)$, $T_{Peierls2} = 59K$ with $Q_{CDW2} = (0.5, 1.260, 0.5)$) [1,2]. Additional to this stationary CDW deformation which occurs when applying direct current, indications for a spatially dependent relaxational behaviour of the CDW have been observed by comparing direct current and pulsed current data [1].

The aim of this experiment was to persue and complete the measurements of the CDW relaxation after deformation by a depinning current pulse.

In preceeding experiments the technique of direct, time-resolved detector readout was tested and established for investigating the CDW time dependence in $NbSe_3$ and first CDW-relaxation data was taken at various positions along the sample length, at different sample temperatures and time resolutions (see experimental report HS961B).

In the experiment reported here, the CDW relaxation was monitored systematically at five positions on the sample, i.e. five distances from the current contacts (40 – 450 μm), at a sample temperature of

T = 100*K* (= $T_{Peierls1}$-45*K*) using a time resolution of 30μs. The necessary spatial resolution on the sample was achieved by closing the slits in front of the sample down to 50μm.

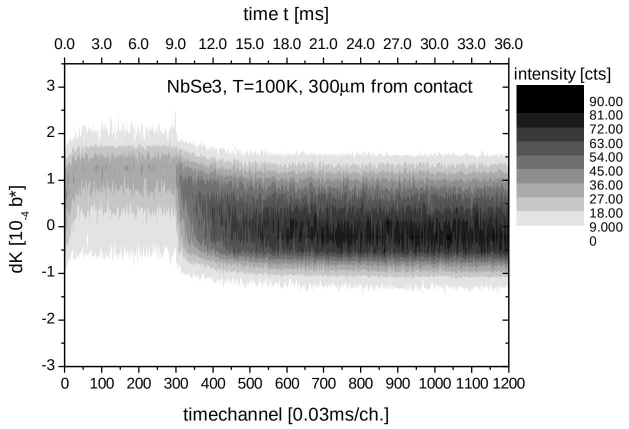

Fig.1: Iso-intensity plot of the time-dependence of the CDW-satellite position (0,K_0+dK(t),0), K_0 being the position after long relaxation.

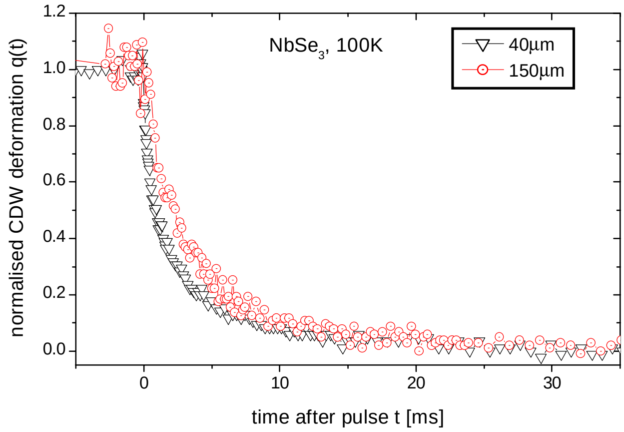

Fig.2: Time dependences of the CDW deformation at two distances from a current contact: 40μm (open triangles) and 150μm (open circles). For comparison the satellite shift is normalised to one.

Fig. 1 shows, as an overview, the CDW-relaxation at a distance of 300μm from a current contact in an iso-intensity plot. During the current pulse (between timechannel 0 and 300), the CDW satellite is shifted in its position K and its peak intensity is reduced. This intensity reduction is essentially due to a strong transverse broadening of the satellite profile as well as by some longitudinal broadening due to not completely homogeneous deformation of the CDW. After the current pulse the CDW returns back towards a relaxed state regaining peak intensity from the re-narrowing satellite profiles.
Fig. 2 shows the time dependence of the CDW deformation after a current pulse for positions at distances of 40μm (open triangles) and 150μm (open circles) from a current contact. For easier comparison the long-time relaxed CDW position K_0 is set to zero with the satellite shift normalised to one. For the 150μm-data one notes the slower relaxation from the deformation by the current pulse. Analysis with a stretched exponential relaxation profile, $q(t) = dK(t)/dK(t=0) = \exp(-t/\tau)^{\mu}$, yields a time scale τ = 1.79*ms*±0.04*ms* for the 40μm data and τ = 3.32*ms*±0.17*ms* for the 150μm data; t = 0 corresponds to the end of the current pulse. This slowing down of the CDW relaxation with increasing distance from the current contact is in good agreement with our earlier data. For the exponent μ one obtains about 0.65±0.10 for both datasets. This value μ differs from values observed earlier. But since the exponent μ in the stretched exponential decay q(t) describes the width of the distribution of relaxation time-scales of the CDW, it may well be, at least partly, sample dependent.

$NbSe_3$ develops two CDW-phases, the two CDWs coexisting in the low-temperature phase $T<T_{Peierls2}$. A part of the beamtime was used for test-measurements to investigate a possible interaction between the longitudinal deformations of the two CDWs. A transverse interaction, i.e. a reduction of the transverse correlation length of the upper CDW (0, 1.241, 0) when depinning the lower CDW, has been reported recently [3]. Our first results obtained during this beamtime indicate indeed an interaction of the longitudinal CDW-deformations (monitored on both CDWs), but the beamtime available did not allow to carry out a systematic study. This interaction seems worth to be investigated in a dedicated experiment.

[1] Requardt et al., PRL **80** (1998) 5631
[2] Brazovskii et al., PR B **61** (2000) 10640
[3] Li et al., PR B **63** (2001) 041103