ESRF	**Interplay of Multiple Charge-Density-Waves and Superconductivity in DyTe3 at High Pressures**	**Experiment number**: HC-1691
Beamline: ID28	**Date of experiment**: from: 27 Sep 2014 to: 03 Oct 2014	**Date of report**: 19 Sep 2015
Shifts: 18	**Local contact(s)**: Paraskevas Parisiadis	*Received at ESRF:*

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Report:

$DyTe_3$ orders into two successive, orthogonal and incommensurate charge-density-wave (CDW) states in the Te-Te planes upon cooling the samples at ambient pressure. Electrical resistivity measurements [1] revealed that pressure reduces the upper CDW transition temperature $T_{CDW,1}$ while enhances the lower $T_{CDW,2}$, suggesting that the two CDWs might merge above 1 GPa, and possibly compete with the pressure-induced superconductivity found at lower temperatures. The objective of this experiments was to determine the temperature-pressure (T-P) phase diagram of single crystals of $DyTe_3$ via high-resolution XRD experiments under pressure and low temperatures. Special interest was concentrated in following the evolution in the T-P phase diagram of the order parameters and of the lattice-distortion characteristic wavevectors q_1 and q_2 associated to the two CDWs.

Single crystals grown at Stanford University were laser-cut at ESRF. $DyTe_3$ is very malleable, and special care had to be taken to not strain the crystals, which turned out to be a difficult a decisive task. The samples were then loaded in three diamond-anvil cells (DACs) using He as pressure medium. We were able to control the temperature from 300 K to 25 K using a closed-cycle cryostat. We utilized a focused x-ray beam of < 10 μm and a 2D plate detector. Samples were aligned with the out-of-plane b axis parallel to the incident beam. Scans consisted in rotations of the DAC-cryostat setup around the vertical axis from -30° to 30° in 0.5° steps, 1-3 second exposures. This resulted in 120 images per (P,T) point.

We performed three T-P runs, one with each DAC. These runs are depicted in Figure 1 (left). In Run #1 the sample was cooled down at constant pressure of 0.5 GPa down to 25 K (points 1 to 7) then pressure was increased at constant T = 25 K to 3.5 GPa (points 7 to 17), and finally warmed up at constant P = 2.7 GPa to 125 K (points 18 to 21). In Run #2, the second DAC cooled down and pressurized in the stair-like case shown by points 22 to 40, also down to 25 K and to a maximum pressure of 3.5 GPa. In the final Run #3, a pressurization scan at 300 K was performed (points 41 to 51) to search for possible structural phase transitions in the whole pressure range of the two CDW states.

Data was analyzed using CrysAlisPro. Lattice refinement resulted In large errors arising probably from multiple rotated crystal phases, and in the best case, 20% of the found peaks were indexed. The percentage of indexed points decreased below 15% at low temperatures and even lower at higher pressures, probably due to degradation of the samples. From Run #3, lattice parameters and unit cell volume decreased linearly as expected, and no indications of structural phase transition were observed up to ~ 4.5 GPa.

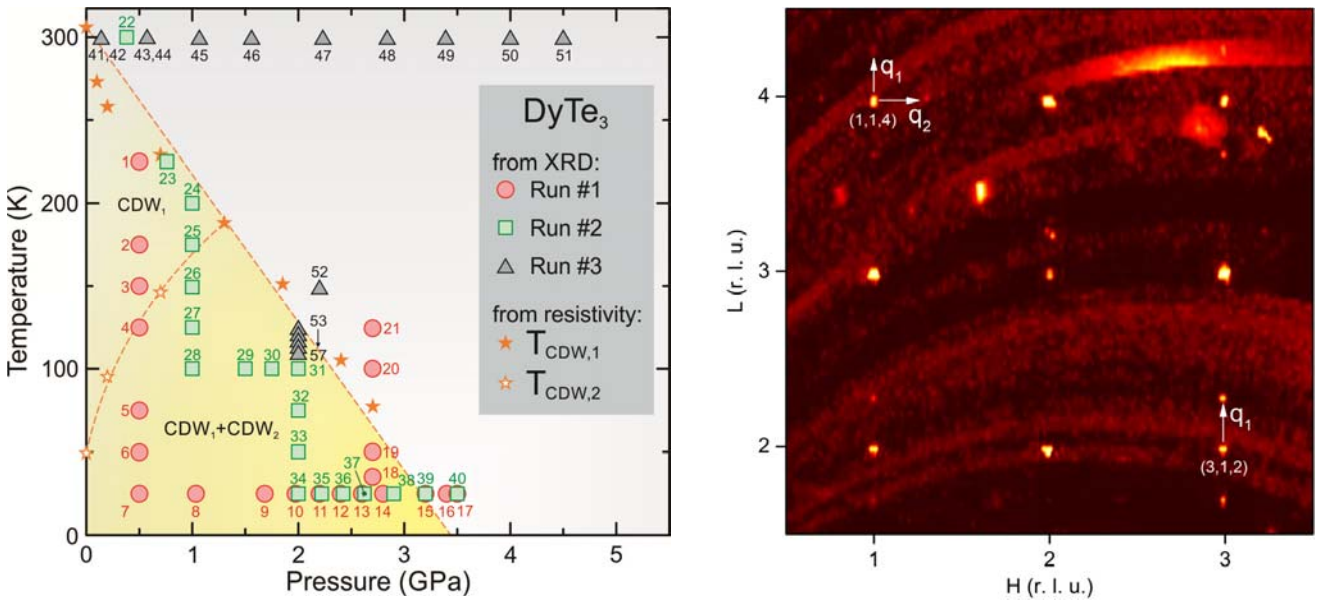

Figure 1 - (left) Temperature vs. pressure phase diagram showing every point measured in this x-ray experiments. Star symbols correspond to the CDW phase boundaries obtained previously from electrical resistivity measurements. (b) Reconstructed (H, 1, L) plane at 125 K and 0.5 GPa (point #4) showing dimmer superlattice peaks.

We were able, to some extent, to follow the CDWs' superlattice peaks in the P-T phase diagram. Single pairs of satellite peaks corresponding to CDW1 appeared upon cooling in Run #1 and #2 (points 1-3 and 23-25), and at lower temperatures and higher pressures, two orthogonal pairs of satellite peaks appeared around certain undistorted lattice positions, shown in the right panel of Figure 1 with the corresponding q-vectors q_1 and q_2. The phase diagram obtained herein is consistent with the previous results from electrical resistivity, and confirms that the lower $T_{CDW,2}(P)$ line increases with pressure until it merges with the $T_{CDW,1}(P)$ line. This suggests that a “double” CDW state seems to be achievable upon crossing a single transition line at high pressures, corroborated with the scans from points 18 to 21 and from 52 to 57.

Sample quality not enough to resolve the difference between q1 and q2, or to follow a satellite peak throughout the whole phase diagram for the determination of the pressure and temperature dependence of the order parameters.

[1] D. A. Zocco *et al.*, Phys. Rev. B **91**, 205114 (2015).