MS44-P09 | Evidence of Charge Density Wave transverse pinning by X-ray micro-diffraction

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In low-dimensional material (quasi-1D in NbSe3 or quasi-2D in TbTe3), a phase transition can occur in which the charge density becomes periodic and a gap opens in the electronic band. This is called the Charge Density Wave (CDW) transition.

Under applied electric field, the CDW will act as an elastic object and deform. Plus, above a threshold field, a collective current appears due to a periodic nucleation of charged topological solitons. In order to fully describe this process, one has to understand the CDW's deformation first.

Several resistivy measurements suggested that sample's surfaces had a strong influence on the CDW behavior, but none could clearly show the origin of this effect.

Here, we present results of x-ray diffraction using a nanometer size beam on a CDW material NbSe3 pre-patterned by a focused ion beam (FIB). This technique enabled us to reconstruct the CDW spatial deformation by simple integration. Surprisingly, the results show a pinning of the CDW at the sample borders, explaining the surface influence on electronic conduction.

Beyond CDW materials, the analytical procedure presented here to reconstruct the CDW phase from a weakly coherent x-ray beam can be applied to recover the phase of any modulation, weakly deformed, with a resolution in the order of the beam size, without the need to use fully coherent x-ray beams.

Finally, using a description at low energy of the CDW deformation, we theoretically showed that surface pinning and nucleation of topological soliton at the contact can fit the resistivy measurements mentioned above.