Tracking Defects of Electronic Crystals by Coherent X-ray Diffraction

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Symmetry **2023**, *15*(7), 1449; https://doi.org/10.3390/sym15071449

In this article, we review different studies based on advanced X-ray diffraction techniques especially coherent X-ray diffraction that allowed us to reveal the behavior of such symmetry-breaking systems as Charge Density Wave (CDW) and Spin density Wave (SDW), through their local phase. After a brief introduction on the added value of using coherent X-rays, we show how the method can be applied to CDW and SDW systems, in both static and dynamical regimes. The approach allowed us to probe the particular sliding state of CDWs systems by observing them through their phase fluctuations, to which coherent X-rays are particularly sensitive. Several compounds stabilizing a CDW phase able to slide are presented, each with a different but clearly pronounced signature of the sliding state. Two main features emerge from this series of experiments which have been little treated until now, the influence of CDW pinning by the sample surfaces and the propagation of periodic phase defects such as charge solitons across the entire sample. Phase models describing the spatial and temporal properties of sliding CDWs are presented in the last part of this review.

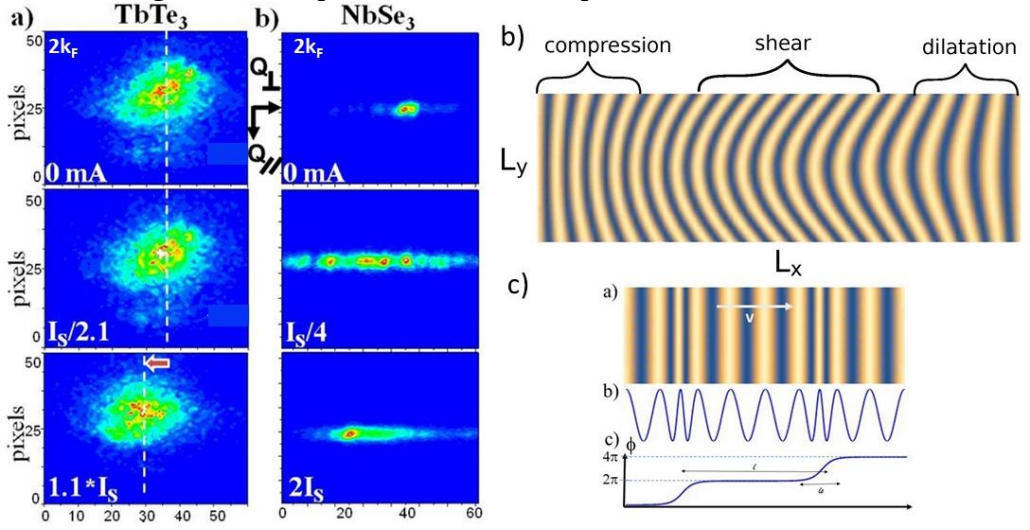

Figure 1 : Illustration of the signature of an sliding CDW obtained by X-ray coherent diffraction in two very different systems: the two-dimensional $TbTe_3$ system and the quasi-one-dimensional $NbSe_3$ system. Below the threshold current Is, the $2k_F$ satellite associated with the ODC widens considerably in $NbSe_3$. B) This effect is due to the curvature effect of the CDW wave front expected when considering the wave pinned by the surface (the phase is then fixed at all surfaces, Dirichlet conditions). Above the current threshold, the satellite tends to return to its initial condition, with the disappearance of speckles. C) This effect is linked to the nucleation of charged solitons, which relax the constraints, and in motion above the threshold.