Dynamic Phase Transition of the Charge-density Wave Lattice

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The dynamic behaviour of the periodic media with lattice imperfections is ubiquitous and long-standing problem in many condensed material systems, because of the correlation to the unusual physical phenomena, for instance, the charge-density waves/spin-density waves to the nonlinear conductivity, the charge/spin stripes to the CMR and the high-T_C superconductivity, and the vortex lattice to superconductivity. In static systems, the imperfections in a medium result in a disordered ground state which prevents the system from forming a long-range order at low temperatures, therefore giving rise to unusual physical properties. In dynamic systems under a driving force, the disordered medium produces a more fascinating phase diagram. Analogous to the vortex lattice, the inhomogeneous distribution of charge densities also forms a periodic lattice below the transition temperature, namely charge-density waves (CDWs). Combining x-ray scattering and multiple diffraction, we demonstrate that the CDW lattice can be driven by a driving force to move and undergo a dynamic phase transition, i.e. from the disordered pinning state $\rightarrow$ ordered moving solid state $\rightarrow$ disordered moving liquid, and the nonlinear conductivity occurs through a phase jump of 2π.

Keywords: charge-density wave, phase transition, x-ray scattering