

## Exploring Lattice Effects at the Charge Ordering Transition in (TMTTF)<sub>2</sub>X

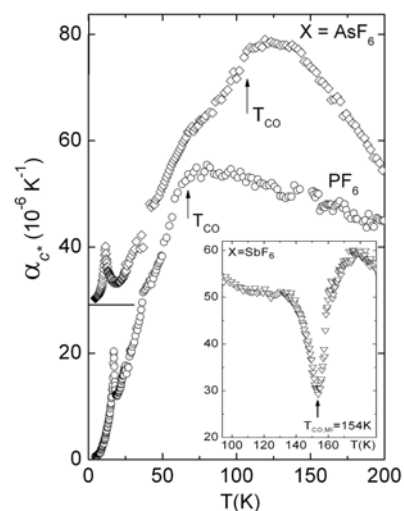
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The experimental observation of a charge-ordering (CO) transition [1] coinciding with the onset of ferroelectricity [2] in the quasi-1D conductors of the (TMTTF)<sub>2</sub>X family revealed the exceptional properties of the Mott-Hubbard insulating phase in these materials. Recently we reported on the role of lattice degrees of freedom in stabilizing the charge-ordered phase in the X = PF<sub>6</sub> and AsF<sub>6</sub> salts [3]. Our results in [3] suggest that above the CO transition temperature  $T_{CO}$ , CO fluctuations, evident from the dielectric measurements [2] to persist up to high temperatures, cause, via S-F contacts, positional fluctuations of the anions towards their new off-center equilibrium positions. These positional fluctuations provide an effective damping of the anions' rigid-unit modes which were made responsible for the negative thermal expansion contribution at high temperatures [3]. Upon cooling through  $T_{CO}$ , however, the CO becomes static, giving rise to a freezing of these modes and, as a consequence, the negative contribution in  $\alpha_{c^*}$  (see figure) is no longer active. Here we review our results of high-resolution thermal expansion measurements at the CO transition on various members of the title substances including the anions X = SbF<sub>6</sub> and Br. For the X = SbF<sub>6</sub> salt, a large  $\lambda$ -type anomaly occurs at  $T_{CO} = T_{\rho}$  (the position of the resistivity minimum), which contrasts with the step-like anomaly at  $T_{CO}$  for PF<sub>6</sub> and AsF<sub>6</sub>. The difference can be understood as a consequence of short-range Coulomb forces in the SbF<sub>6</sub> salt, where CO coincides with a metal-insulator (MI) transition, as compared to long-range forces in the AsF<sub>6</sub> and PF<sub>6</sub> salts where  $T_{CO} < T_{\rho}$ . For the X = Br salt, the negative contribution in  $\alpha_{c^*}$  is absent, consistent with the model proposed in [3].



[1] D.S. Chow *et al.*, Phys. Rev. Lett. **85** (2000) 1698.

[2] P. Monceau *et al.*, Phys. Rev. Lett. **86** (2001) 4080.

[3] M. de Souza *et al.*, Phys. Rev. Lett. **101** (2008) 216403.