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先进材料学域
ADVANCED MATERIALS THRUST
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Charge Density Wave Order in the Non-Stoichiometric Mineral Rickardite $Cu_{1.4}Te$

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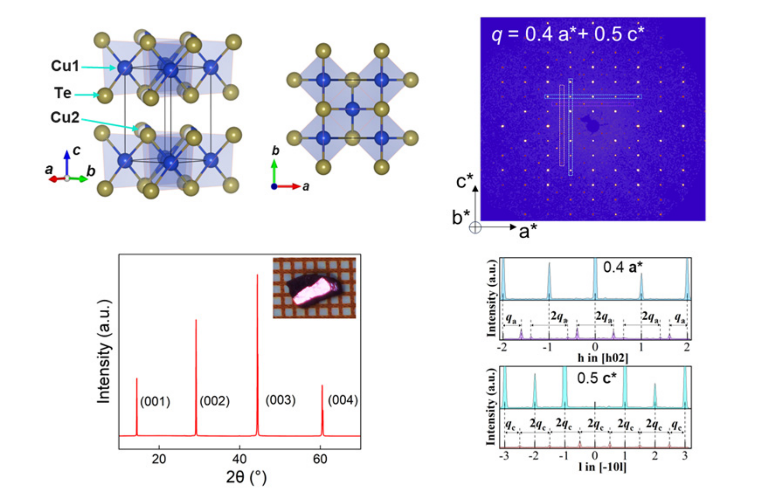
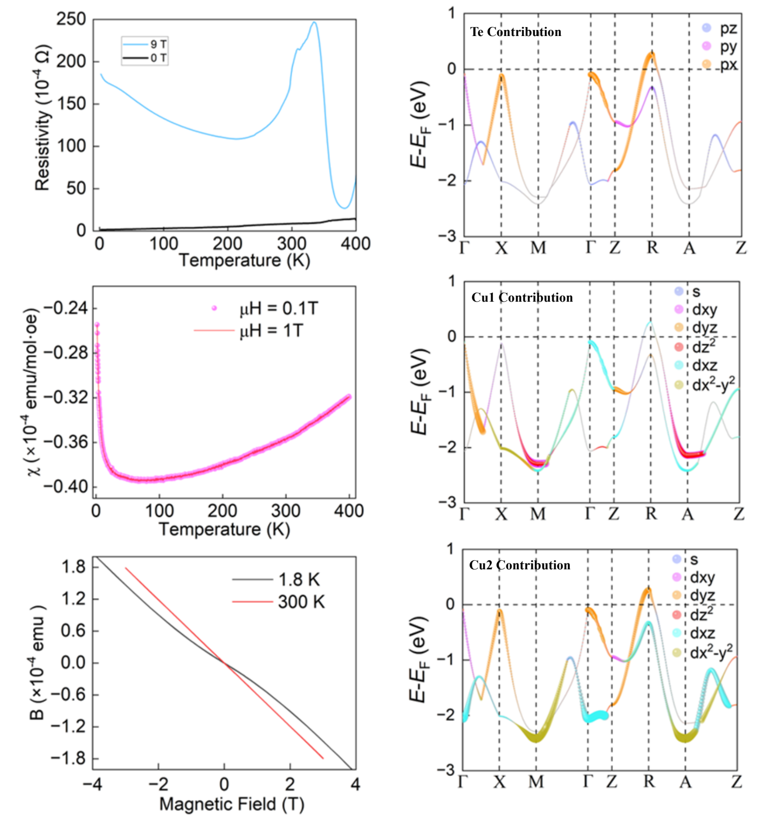
Abstract: Charge density waves (CDWs) is a collective modulation of electron density, offering profound insights into electron-phonon coupling, Fermi surface nesting, and metal-insulator transition in condensed matter physics. The Cu-Te system constitutes a complex family of compounds, with phase formation dependent on the Cu/Te ratio—encompassing stoichiometric phases such as hexagonal Cu_2Te (weissite type) and orthorhombic CuTe (vulcanite type), as well as non-stoichiometric $Cu_{3-x}Te_2$ (tetragonal, rickardite type)—which exhibit rich CDW modulation. Among these compounds, we found the mineral rickardite $Cu_{1.4}Te$ demonstrate a wave vector that incorporates the 0.4 $\boldsymbol{a}^*$, which is consistent to CDW vector of CuTe, despite substantial structural differences (e.g., Cu coordination environments and vacancy distribution). Here, we employ angle-resolved photoemission spectroscopy (ARPES) to study the electronic structure and CDW gap of $Cu_{1.4}Te$. Our study aims to determine the relative roles of electron-phonon coupling and Fermi surface nesting in stabilizing its CDW state, shedding light on the universality of CDW interactions across the diverse Cu-Te phase family.

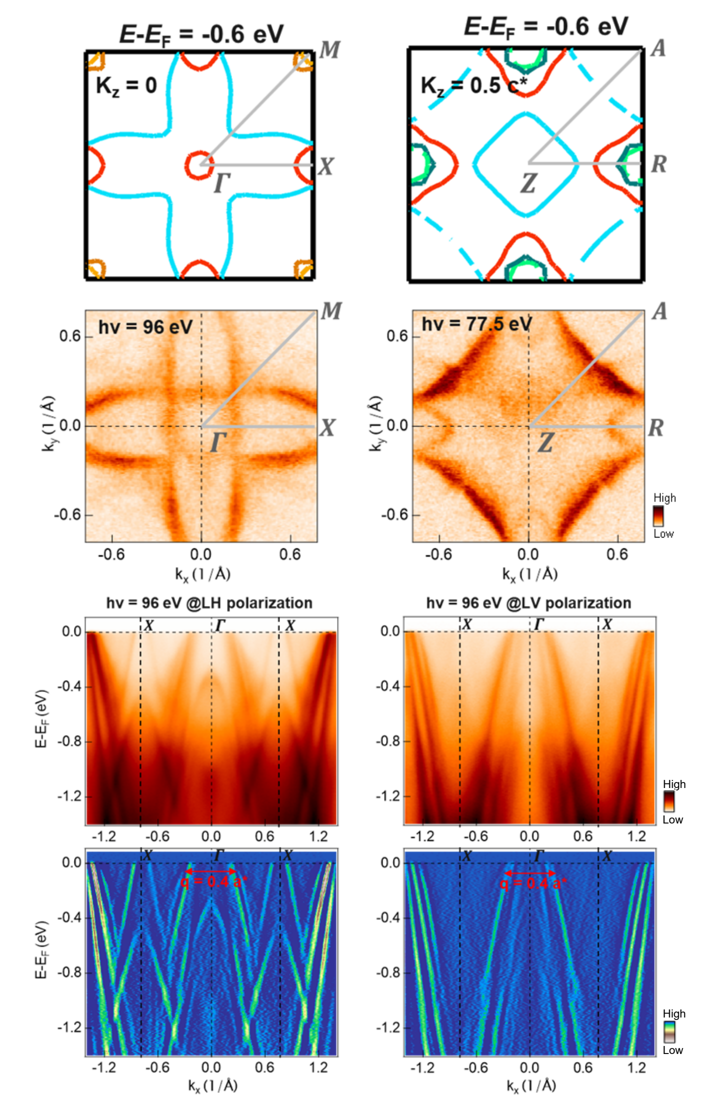
Crystal Structure and CDW



Transport Measurement and DFT Calculation



Fermi Surface and Electronic Structure



Conclusion: We have identified rickardite $Cu_{1.4}Te$ as a novel charge density wave (CDW) system. In high-quality single crystals, ARPES measurements reveal Fermi surface nesting with a wave vector that matches the in-plane modulation determined by SXRD. DFT calculations demonstrate that the resultant gap originates from a commensurate 5×1×2 superstructure involving Cu vacancies. This multi-method study conclusively attributes the superstructure modulation to a CDW mechanism, expanding the landscape of CDW materials in the Cu-Te family.