Temperature dependence resonant inelastic X-ray scattering study on charge density order in T*-type copper-based superconductors.

In this report, we studied the temperature dependence charge order feature for the 214-type T* phase SLSCO through the RIXS technique. We observed a markedly different evolution of the charge order wavevector in SLSCO compared to that of traditional 214-type cuprates. Additionally, we noted a potential distinction between the combined CDW+CDF mixture and an isolated CDF signal.

In cuprate research, the different phases within the pseudogap region have consistently drawn significant interest from scientists. The charge order phenomenon is a hot topic in current discussions [1]. Recently, the resonant inelastic X-ray scattering (RIXS) studies revealed that very short-range charge order called charge density fluctuation (CDF) is almost ubiquitously observed at high temperatures for all cuprates [2][3]. In this report, we studied the temperature dependence feature of the charge order of the long-time left-visited 214-type T* phase cuprate $SmLa_{0.75}Sr_{0.25}CuO_4$ (SLSCO) for the first time. Our prior ARPES studies estimate an effective hole concentration of ~ 10% in this sample [4]. The experiment is performed at ADRESS-RIXS, Swiss Light Source (SLS), Paul Scherrer Institute (PSI), Switzerland.

Fig.1 shows the temperature dependence integral intensity of the quasi-elastic peaks along the (h, 0) direction plotted as the dotted data. The colorful solid line represents the fitting results obtained using the Lorentzian profile. The peak position centered at h ~ 0.29, except 250 and 290 K, caused by the strong background that affected the fitting. Figure 2 displays the peak heights and widths (full width at half maximum). It is evident that the peak height decreases steadily, while a clear "kink" in the peak width emerges near 100 K.

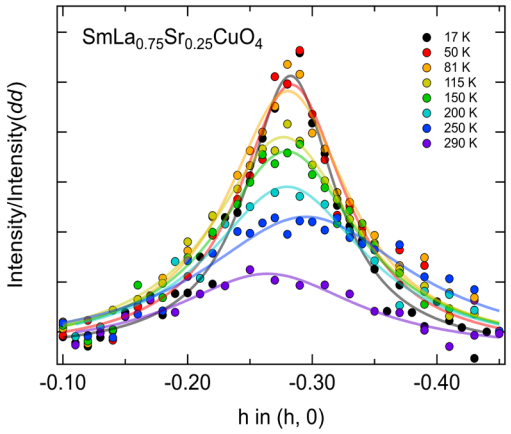

Fig. 1 Integral intensity of quasi-elastic peaks.

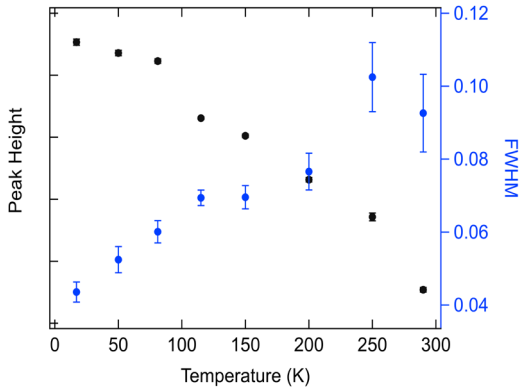

Fig. 2 Peak height and FWHM against temperatures.

The results indicate that the charge order wavevector's position in SLSCO deviates from that of conventional 214-type cuprates, which are closer to the non-214-type families [5]. A potential reason could be the significantly weaker magnetism in T* phase cuprates, which disrupts the coupling between spin and charge order, leading to a conventional charge density wave (CDW) instead of stripe order. We conclude that two similar peaks also appeared in our samples: the broad CDF peak and the narrow CDW peak. This assumption could reflected in the distinct evolution of the peak width at ~ 100 K, which could be attributed to the separation of the mixture CDW+CDF and single CDF state. However, cause of the limited Instrument resolution in ADRESS-RIXS (~ 122 meV), we couldn't detect the additional peak in the current results. An improved high-resolution RIXS experiment is needed.

References

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