Self-Energy and the Electronic Structure of Correlated Metal SrVO₃

The correlated electronic structure of SrVO₃ has been investigated by angle-resolved photoemission spectroscopy (ARPES) using in situ prepared thin films. Pronounced features of band renormalization have been observed as in the high-\(T_c\) cuprates, such as a sharp kink ~60 meV below the Fermi level (\(E_F\)). We have deduced the electron self-energy, which represents the interaction in a solid, in a wide energy range by applying the Kramers-Kronig relation to the photoemission spectra. The obtained self-energy indicates a large energy scale of ~0.7 eV, which is attributed to electron-electron interaction and gives rise to the incoherent peak ~1.5 eV below \(E_F\). The present analysis enables us to obtain a consistent picture for both the high-energy incoherent state and the low-energy band renormalization.

The effect of many-body interaction on the electronic structure, such as electron correlation or electron-phonon interactions, is an important concept for understanding the physical properties of materials. In a correlated electron system, coupling of single-particle excitations with collective excitations such as phonons, leads to a pronounced energy-dependent band renormalization, a so-called kink, in the band dispersion. In the high-\(T_c\) cuprate superconductors, a kink has been observed around 60 meV below \(E_F\) [1] by angle-resolved photoemission spectroscopy (ARPES) and the origin of the kink has been under debate for a long time. Studies of kinks in transition-metal oxides other than the cuprates would give useful information. SrVO₃ (SVO) is a perovskite-type transition-metal oxide (TMO) and is a prototypical Mott-Hubbard-type oxide with a narrow gap and large bandwidth. It is regarded as the remnant of the lower Hubbard band [2].

Figure 1: ARPES spectra of SrVO₃ along the \(k\) direction taken at the photon energy of 66 eV with linear polarization. The clear band dispersion near \(E_F\) is the d band.

Figure 2: Band dispersions and self-energies in the vicinity of the Fermi level. (a) QP band dispersions are determined by the peak positions (blue dots). The position of the kink at 60 meV is shown by an arrow. The noninteracting band given by the band-structure calculation is shown by red curves. The real part of the self-energy \(\Sigma\) can be obtained as the difference between the QP band dispersion and the noninteracting band dispersion. (b) Self-energy deduced from the measured ARPES spectra using the KK transformation.

REFERENCES

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