Temperature-dependent electronic structure measurements of CrSBr

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Abstract

In recent years, chromium sulphur bromide (CrSBr) has emerged as a promising highly-anisotropic semiconducting two-dimensional (2D) magnetic material to explore spintronics and quantum transport due to its strongly correlated quasiparticle interactions [1]. CrSBr is an A-type layered antiferromagnet; in the bulk material, above the Néel temperature (T_N = 132K) it transitions to an intermediate ferromagnetic phase before becoming paramagnetic at high temperature. Experimental work on its fascinating optoelectronic properties has been heavily supported by electronic structure calculations using a variety of methods [2,3], but direct band structure measurements to test these predictions are still lacking. Recent angle-resolved photoemission microscopy (ARPES) measurements of bulk CrSBr were unable to measure below T_N due to charging effects [4]. Here, we overcome this limitation through exfoliation of CrSBr flakes onto a template-stripped gold surface (Figure 1a) [5]. Using the nanoARPES endstation of the i05 beamline at Diamond Light Source, ARPES was acquired without charging from thin flakes (~10 nm thick) at temperatures down to < 40 K. Photon energy, and polarisation, dependent measurements confirm a strongly 2D dispersion and link the band dispersions to different atomic orbitals. Temperature-dependent measurements highlight electronic structure changes through the magnetic phase transitions, including shifts of the low energy valence bands and band splitting suggestive of spin-ordering (Figure 1b,c). These results also demonstrate a simple approach for the measurement of the low-temperature band structure of insulating layered materials.

References

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Figures

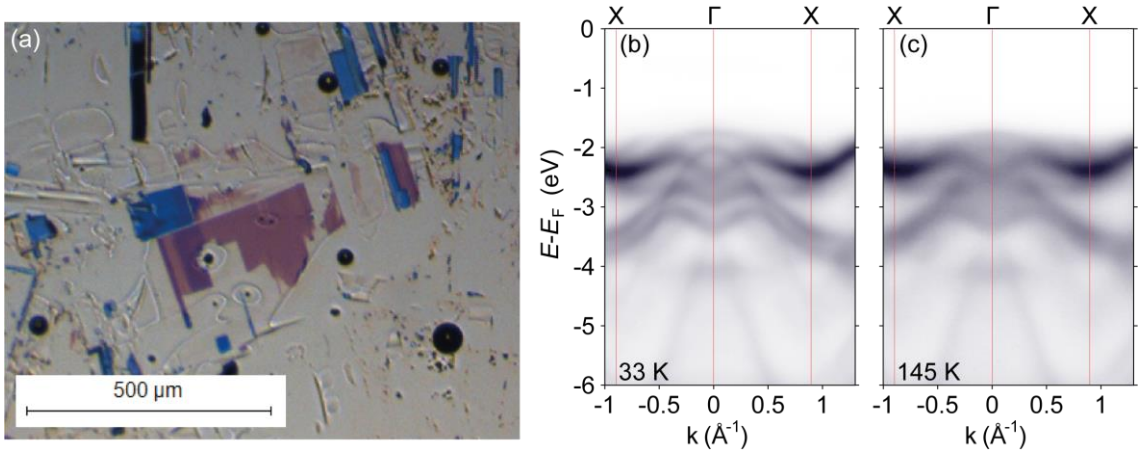

Figure 1: a) Optical image of CrSBr flakes exfoliated on to gold. b,c) ARPES spectra of CrSBr along the X-Γ-X direction (b) below and (c) above T_N at a photon energy of 90 eV.