Angle-resolved photoemission spectroscopy on chromium films

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Chromium films offer an excellent system to study the impact of dimensional confinement on physical properties associated with the spin-densitywave (SDW) ground state observed in bulk materials. These properties are also of some technological importance since chromium is a common component of thin film magnetic structures. We prepared chromium (1 1 0) films of high crystalline quality on a W(1 1 0) substrate with a wedge-shaped thickness profile so that the impact of confinement can be systematically studied. We have characterized these films using a combination of low-energy electron diffraction and microscopy as well as high-resolution angle-resolved photoemission spectroscopy. We have probed the Fermi surface and the nesting vectors therein that are relevant to the SDW ground state. We find these to predict accurately the observed bulk SDW periodicity. We have also characterized the SDW periodicity in the film directly by measuring the splitting between backfolded bands, and we find that this periodicity deviates markedly from the bulk periodicity for thinner films at higher temperatures. We have systematically mapped the SDW incommensurability and phase diagram as a function of both film thickness and temperature. We find commensurate and incommensurate phases that are separated by nearly continuous transitions. Our results suggest a simple model to explain the delicate interplay between commensurate and incommensurate phases that involves a balance between SDW stabilization energy and surface and interface energetics.