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Surface structure of SmB₆ investigated by STM and HAXPES¹

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The intermediate-valence compound SmB₆ is typically considered a “Kondo insulator” albeit the concept of the Kondo effect does, in principle, not hold for an intermediate-valence material. Nonetheless, the hybridization between conduction electrons and the strongly interacting Sm *f*-electrons results in a gap at the Fermi energy and hence, an insulating ground state arises at temperatures below about 40 K. Recently, SmB₆ has become of enormous topical interest because it is a candidate material for hosting topologically protected surface states. The intermediate valence of Sm in SmB₆ was confirmed by HAXPES measurements down to 5 K. Such measurements conducted at high photon energies for improved probing depth are of importance in view of valency limits given for strong topological insulators [1]. Scanning tunneling microscopy (STM) has the unique capability of providing combined topographic and spectroscopic information. We conducted STM on numerous samples cleaved *in situ* at around 20 K [2]. Cleavage along the {001} plane of the cubic structure through breaking inter-octahedral B-B bonds gives rise to polar surfaces. In result, we found disordered chain-like as well as ordered (2 × 1) surface reconstructions. Occasionally, we also observed patches of non-reconstructed surface areas of both, Sm and B termination. On such areas, we found indications for the Kondo effect being at play. Also, for non-reconstructed surface areas of some ten nanometers in size the *dI/dV*-curves can be well described by a Fano resonance. Thus, the hybridization picture typically considered for this material could be fully confirmed. All types of surfaces, reconstructed and non-reconstructed, displayed a finite zero-bias conductance of considerable magnitude. This finding, in spite of different surface topologies, confirms the robustness of the metallic states and is in line with the proposal of SmB₆ being a topological insulator.

[1] V. Alexandrov *et al.*, Phys. Rev. Lett. **111** (2013) 226403.

[2] S. Rößler *et al.*, Proc. Natl. Acad. Sci. USA **111** (2014) 4798.

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