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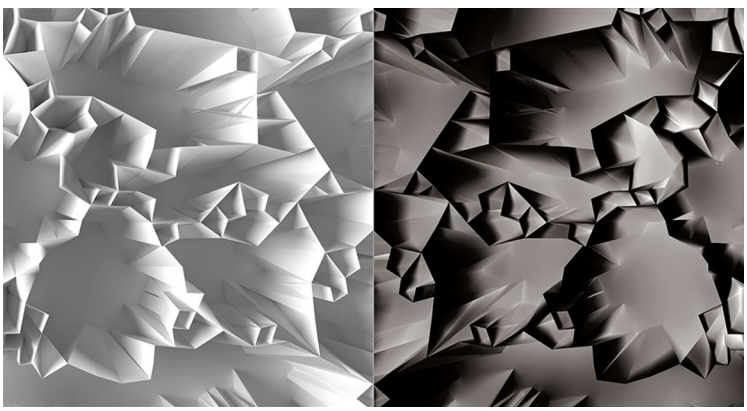
CORRELATED ELECTRON SYSTEMS

Contrast reversal provides clues

SmB_6 is a strongly correlated material that has an insulating bulk and conducting surface states. If these surface states are topological, they could give rise to a new state of matter — a correlated topological insulator. However, the nature of the surface states is still disputed. Angle-resolved photoemission spectroscopy (ARPES) measurements show two distinct surface states, but scanning tunnelling microscopy (STM) data have suggested several surface terminations of the crystal. Writing in *Advanced Materials*, Hannes Herrmann and colleagues combine ARPES and STM measurements of the same crystal to gain a better understanding of the SmB_6 surface.

A direct comparison of ARPES and STM data is tricky as ARPES averages over large areas, whereas STM is a local probe. Owing to non-uniformities in the crystal surface, STM data vary between studies, but the microscopic origin of these differences is unclear. Usually, samarium atoms dominate the STM data, but by reversing the bias of the STM tip, Herrmann and co-workers found that the contrast is reversed, revealing the boron atoms in some images. This enables the identification of different parts of the crystal as being B-terminated or Sm-terminated. By assigning this information to the ARPES spectra of the corresponding parts of the crystal, a comparison between the B-terminated and Sm-terminated surfaces can be made.



Credit: Ivan Mollov / Alamy Stock Photo

In previous work, ARPES spectra have shown a small energy shift between the B-terminated and Sm-terminated surfaces, which provides a simple, non-topological, explanation for the surface states. This shift has now been corroborated with new STM data, lending support to this theory. Although the debate over the SmB_6 surface states is likely to continue, this study provides a more consistent understanding of the results provided by different measurements methods.

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ORIGINAL ARTICLE Herrmann, H. et al. Contrast reversal in scanning tunneling microscopy and its implications for the classification of SmB_6. *Adv. Mater.* https://doi.org/10.1002/adma.201906725 (2020)