Universität Hamburg
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University of Hamburg, Jungiusstr. 11, 20355 Hamburg

University of Hamburg
Jungiusstr. 9A-11A
20355 Hamburg

Heiko Fuchs
Public Relations

Tel.: +49 - 40 - 428 38 - 69 59
Fax: +49 - 40 - 428 38 - 24 09
hfuchs@physnet.uni-hamburg.de

Press release

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Interfacial Superconductivity

Magnetic and superconducting order revealed simultaneously

Researchers from the University of Hamburg in Germany, in collaboration with colleagues from the University of Aarhus in Denmark, have synthesized a new superconducting material by growing a few layers of an antiferromagnetic transition-metal chalcogenide on a bismuth-based topological insulator, both being non-superconducting materials. While superconductivity and magnetism are generally believed to be mutually exclusive, surprisingly, in this new material, superconducting correlations spatially coexist with antiferromagnetism. Most remarkably, the team headed by Professor Roland Wiesendanger was able to observe this coexistence for the first time on the atomic scale using spin-resolved scanning tunneling microscopy and spectroscopy. These exciting results, reported in today's issue of *Nature Communications,* challenge the understanding of the nature of electronic Cooper-pairing in iron based superconductors, which is the class of superconducting materials most heavily studied in recent years.

The discovery of high-temperature superconductivity in iron based compounds initiated numerous studies on the relationship between magnetic and superconducting order by various experimental and theoretical methods. Moreover, the unusual enhancement of the superconducting transition temperature by interface effects, as reported a few years ago for the case of ultrathin FeSe films grown on $SrTiO_3$ substrates, created additional excitement in the scientific community. Interestingly, in contrast to FeSe, the related compound FeTe does not exhibit a superconducting phase, but shows antiferromagnetic ordering up to a critical temperature of about 70 K. Therefore, it is even more remarkable that ultrathin FeTe films grown on non-superconducting Bi_2Te_3 substrates show clear signs of superconductivity. The coupling of a superconductor to a topological insulator such as Bi_2Te_3, as realized in the experiments by the Hamburg group, is not only interesting from a fundamental research point of view: It has been theoretically predicted that such hybrids can host Majorana Fermions in the center of superconducting vortex cores formed upon the application of an external magnetic field. Majorana Fermions are currently widely explored in different research disciplines as a new platform for fault-tolerant quantum computation. The fascinating results obtained for

FeTe/Bi_2Te_3 heterostructures can therefore be regarded as an important step towards the experimental realization of such dreams.

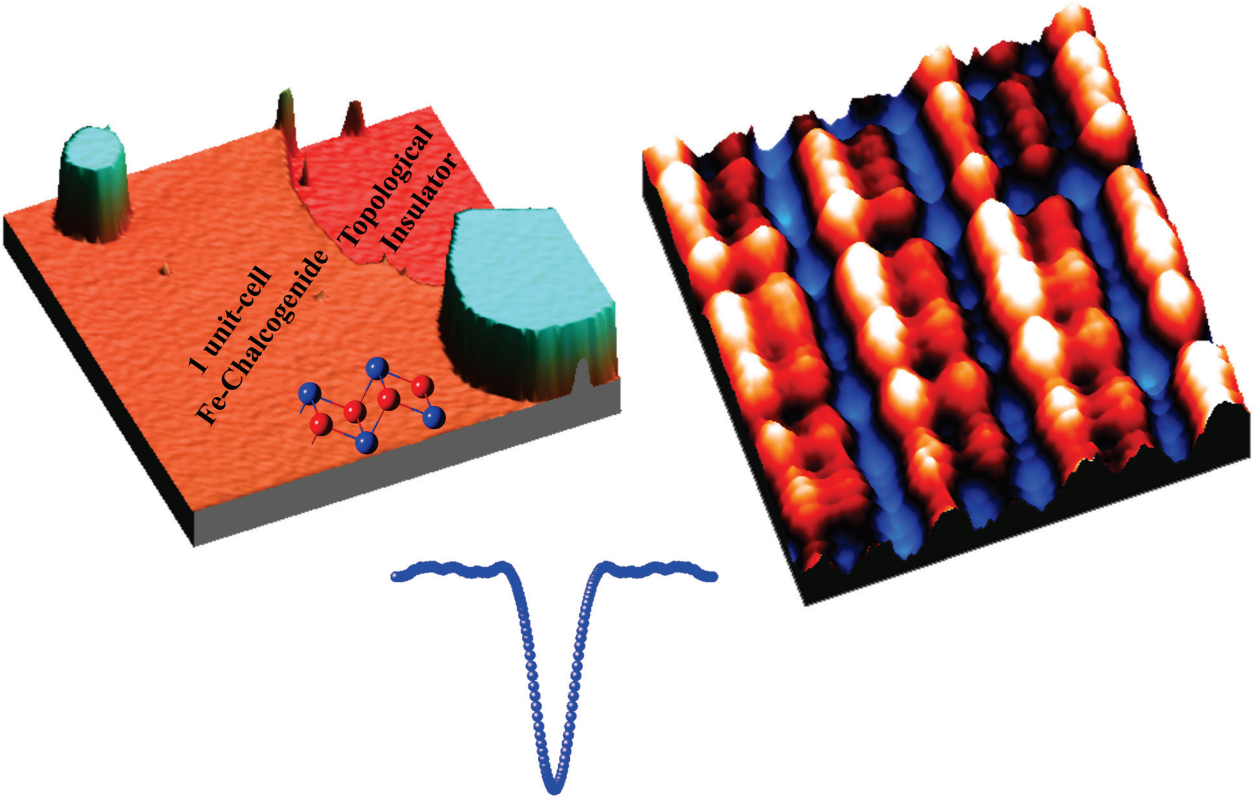

Figure: (left) Scanning tunneling microscopy (STM) image (perspective view) of a heterostructure interface consisting of two non-superconducting materials, namely a topological insulator as substrate and an ultrathin film of iron-telluride grown on top. The unit-cell high layer of FeTe exhibits simultaneously bi-collinear antiferromagnetic order as revealed by spin-resolved STM (right) and superconducting properties at the same location as measured by the spectroscopic STM mode (bottom).
(Image source: S. Manna and R. Wiesendanger, University of Hamburg, Germany)

Original publication:
Interfacial superconductivity in a bi-collinear anti-ferromagnetically ordered FeTe monolayer on a topological insulator,
S. Manna, A. Kamlapure, L. Cornils, T. Hänke, E. M. J. Hedegaard, M. Bremholm, B. B. Iversen, Ph. Hofmann, J. Wiebe, and R. Wiesendanger,
Nature Communications, online publication: 17.01.2017,
DOI: 10.1038/NCOMMS14074.

Further related work in the recent literature:
Reorientation of the diagonal double-stripe spin structure at $Fe_{1+y}Te$ bulk and thin film surfaces,
T. Hänke, U. R. Singh, L. Cornils, S. Manna, A. Kamlapure, M. Bremholm, E. M. J. Hedegaard, B. B. Iversen, Ph. Hofmann, J. Hu, Z. Mao, J. Wiebe, and R. Wiesendanger,
Nature Communications 8, 13939 (2017), online publication from 06.01.2017.

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Additional web sites:
http://www.nanoscience.de
http://www.nanoscience.de/astonish

Additional information:

Prof. Dr. Roland Wiesendanger and
University of Hamburg
Jungiusstr. 9A/11A
D-20355 Hamburg

Phone: +49- 40 - 4 28 38 - 52 44
Fax.: +49- 40 - 4 28 38 - 24 09
E-mail: wiesendanger@physnet.uni-hamburg.de
E-mail: hfuchs@physnet.uni-hamburg.de