IEEE/CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), October 2017.
Poster presentation Th-HYP-12 given at ISEC 2017, Sorrento, Italy.

VITI Virtual Institute for Topological Insulators

MESA+ INSTITUTE FOR NANOTECHNOLOGY

JÜLICH FORSCHUNGSZENTRUM

In-situ Fabrication of Topological Superconducting Hybrids

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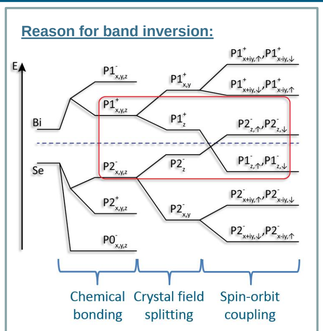
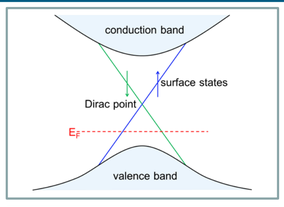
Topological Insulators (with Cap)

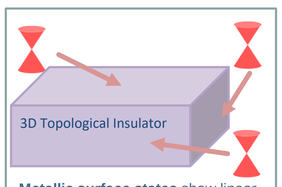
Reason for band inversion:



Large Spin-orbit coupling leads to band inversion

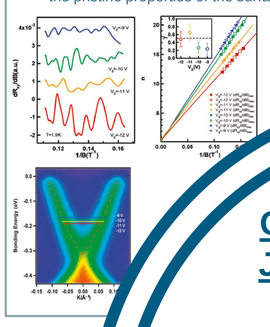
H. Zhang et al.,Nature Physics 5, 438 (2009)





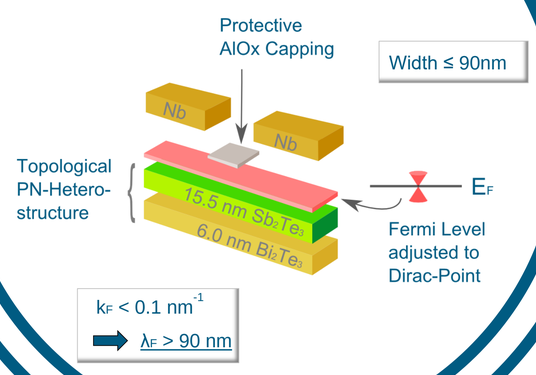
Metallic surface states show linear dispersion and spin-locked momentum!

2nm of in situ Aluminium capping immediately oxidizes after exposure to air and in this way protects the pristine properties of the surface states.



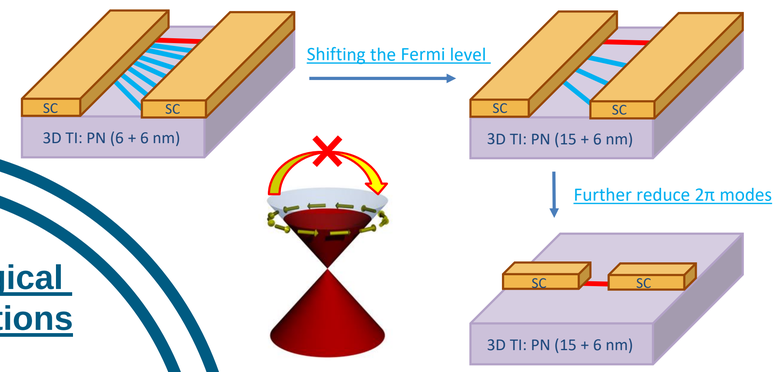
Lang et al. (2012) ACS Nano 6, pp 295-302

Quasi 1D topological Josephson Junctions



$k_F < 0.1\ nm^{-1}$ ➡ $\lambda_F > 90\ nm$

Majorana Bound State



Wiedenmann et al. Nature Comm, 7, 10303 (2015)

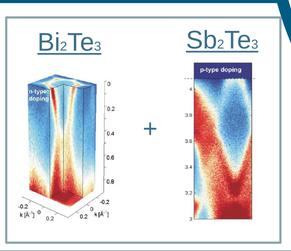
Adjusting E_F to Dirac-Point

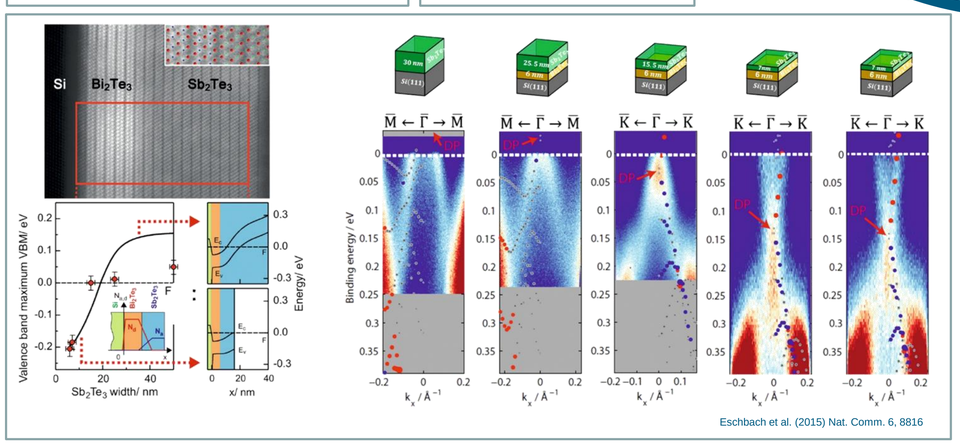
Pure Sb_2Te_3 is p-type doped, due to Sb vacancies and Sb_{Te} antisites.

Pure Bi_2Te_3 is n-type doped, due to Te_{Bi} antisites.

By growing a stack of p-type Sb_2Te_3 on top of n-type Bi_2Te_3 one can shift the Fermilevel through the cone and adjust it to the Dirac-Point.

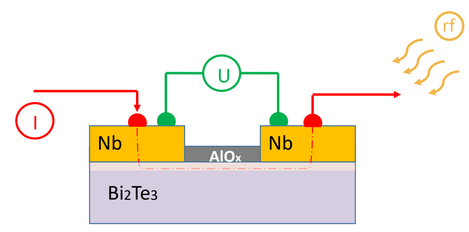
The small k_F leads to a **λ_F > 90 nm!**

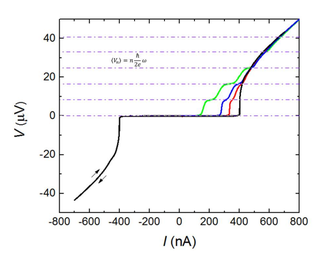


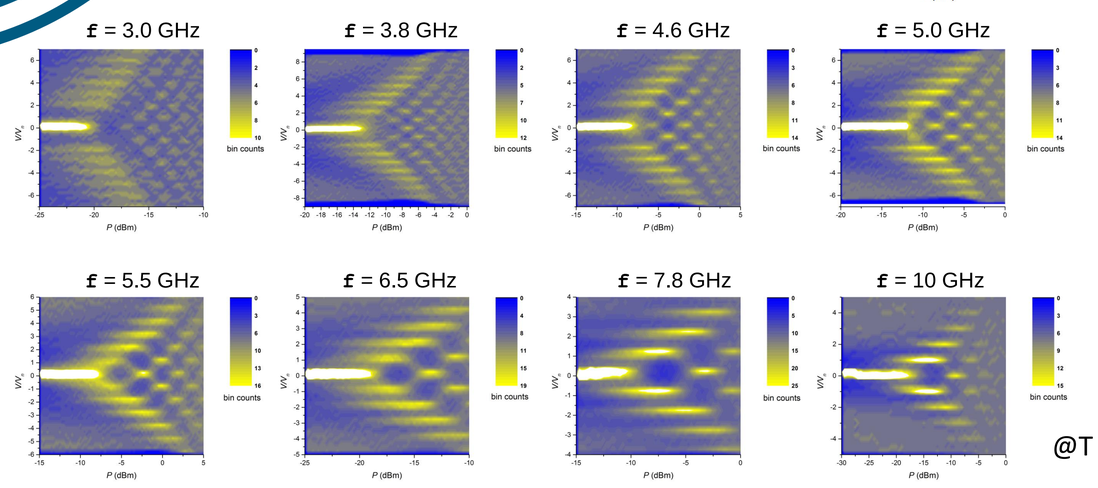


Eschbach et al. (2015) Nat. Comm. 6, 8816

Shapiro steps measurements

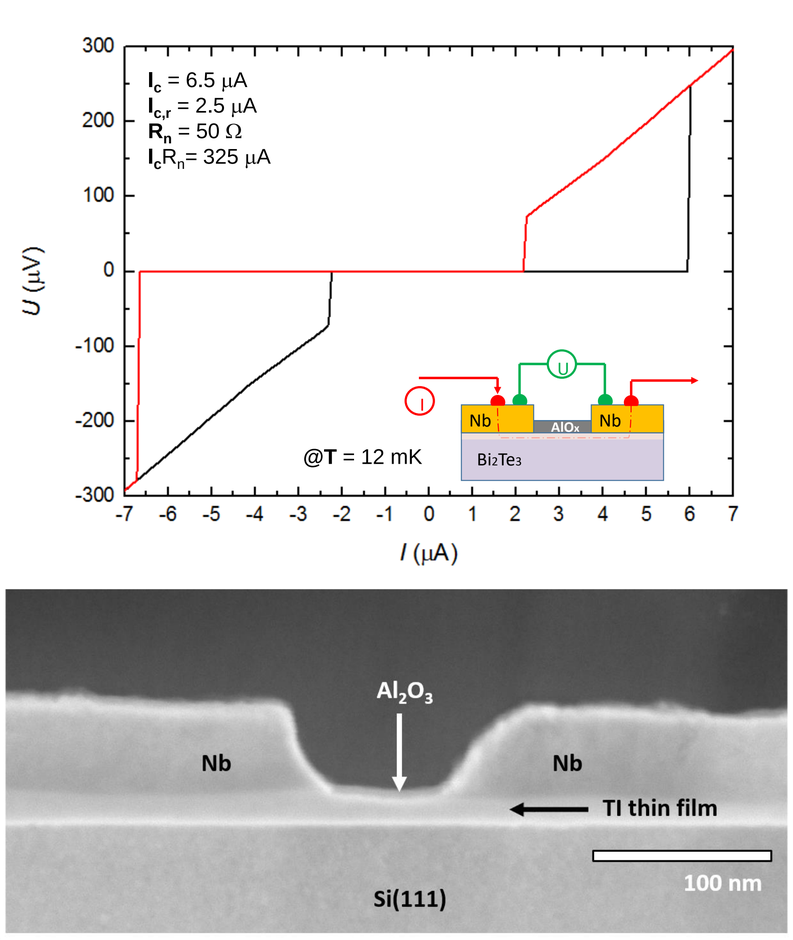


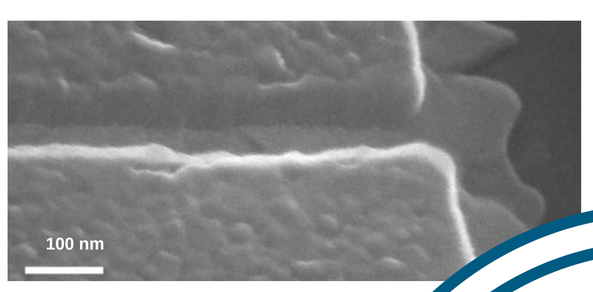


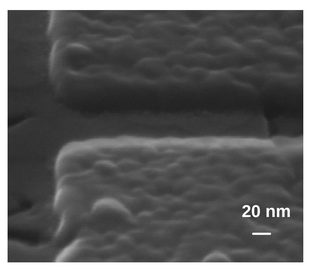


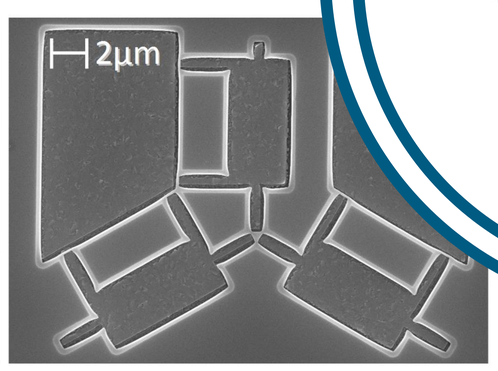
@T = 1.5 K

Stencil Lithography









Grown Majorana-Qubits

Superconductor (blue) via Stencil Lithography

Topological insulator (light grey) via selective growth

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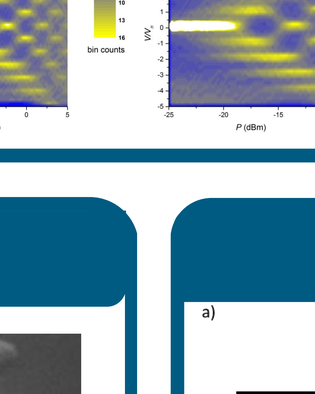
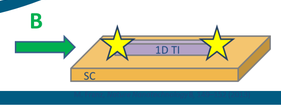


Selective Growth

Substrate fabrication and selective growth:
a) Clean Si.
b) SiO_2 and Si_3N_4 deposition.
c) Nanopatterning (EBL and RIE).
d) HF dip.
e) Selective TI growth.
f) In situ Al capping.

Selective area growth of topological insulators.
a) T_{Sub} = 280 °C: TI grows in Si trenches and on top of Si_3N_4.
b) T_{Sub} = 290 °C: TI growth selectively only on Si.
c) T_{Sub} = 300 °C: TI growth nowhere.
d) Al capping deposited on top of filled trenches at T_{Sub} = -30 °C.



Mitglied der Helmholtz-Gemeinschaft