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Visualizing the inhomogeneous response of Dirac surface states to bulk disorder in topological insulators[1] HAIM BEIDENKOPF, PEDRAM ROUSHAN, JUNGPIL SEO, LINDSAY GORMAN, ILYA DROZDOV, Joseph Henry Laboratory, Department of Physics, Princeton University, Princeton, New Jersey 08544, USA, YEW SAN HOR, ROBERT J. CAVA, Department of Chemistry, Princeton University, Princeton, New Jersey 08544, USA, ALI YAZDANI, Joseph Henry Laboratory, Department of Physics, Princeton University, Princeton, New Jersey 08544, USA — The Dirac dispersion and helical spin texture of surface states in topological insulators render them resilient to backscattering. This remarkable property, assured by time reversal symmetry, should give rise to enhanced surface conductivity as the Dirac states anti-localize in presence of disorder. We have used scanning tunneling microscopy (STM) and spectroscopy to study the response of the surface states to both magnetic and non-magnetic dopants [HB et al. Nat. Phys. doi:10.1038/nphys2108]. We find that helicity provides protection from scattering, irrespective of the magnetic nature of the individual scaterrers and even of ferromagnetic correlations among them. However, the charged defects in the bulk induce pronounced fluctuations in energy, momentum and helicity of the surface states. Agreement with a theoretical model, derived for the response of Dirac states to charged disorder in graphene, further implies that such fluctuations limit the attainable surface mobility. Although we show that the potential energy landscape induced by the bulk defects does not localize the Dirac surface states, our results suggest that reducing charged defects content is essential for tuning the chemical potential to the Dirac energy and enhancing mobility of the novel surface states.

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