MAR13-2012-020124

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Topological Insulators: A New Platform for Fundamental Science and Applications

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Topological insulators constitute a new phase of quantum matter whose recent discovery has focused world-wide attention on wide-ranging phenomena in materials driven by spin-orbit coupling effects well beyond their traditional role in determining magnetic properties. I will discuss how by exploiting electronic structure techniques we have been able to predict and understand the characteristics of many new classes of binary, ternary and quaternary topologically interesting systems. [1-4] The flexibility of chemical, structural and magnetic parameters so obtained is the key ingredient for exploring fundamental science questions, including novel spin-textures and exotic superconducting states, as well as for the realization of multi-functional topological devices for thermoelectric, spintronics, information processing and other applications. [5-7] I will also highlight new insights that have been enabled through our material-specific modeling of angle-resolved photoemission (ARPES) and scanning tunneling (STS) spectroscopies of topological surface states, including effects of the photoemission and tunneling matrix element, which is well-known to be important for a robust interpretation of various highly resolved spectroscopies. [8,9] Work supported by the Materials Science & Engineering Division, Basic Energy Sciences, U. S. D. O. E.

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