Intrinsic Magnetism at Silicon Surfaces

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It has been a long-standing goal to create magnetism in a nonmagnetic material by manipulating its structure at the nanometer scale. I describe our recent theoretical prediction that certain stepped silicon surfaces stabilized by adsorbed gold realize this goal by self-assembly, creating linear chains of fully polarized electron spins with virtually perfect structural order. The spins are localized at the silicon step edges, which have the form of graphitic hexagonal ribbons. The predicted magnetic state is indirectly supported by recent experimental observations, such as the coexistence of double- and triple-period distortions. More direct evidence from two-photon photoemission and scanning tunneling spectroscopy confirms our prediction of an unoccupied silicon state that arises from strong exchange splitting. Ordered arrays of spins at a surface offer access to local probes with single spin sensitivity, such as spin-polarized scanning tunneling microscopy. This integration of structural and magnetic order suggests a possible new avenue toward technologies involving spin-based computation and storage at the atomic level.