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Epitaxial Growth of Artificial Graphene on Conventional Semiconductor Surface towards Room Temperature Topological Quantum States[1] MIAO ZHOU, WENMEI MING, ZHENG LIU, ZHENGFEI WANG, FENG LIU, University of Utah — Graphene is a 2D hexagonal lattice made of sp^2 hybridized carbon. Fundamental understanding of graphene has recently spurred a surge of searching for 2D topological quantum phases in solid-state materials. Here we demonstrate the epitaxial growth of artificial graphene, in which the carbon atoms are replaced by other elements, on conventional semiconductor surface to realize large-gap topological quantum phases. We show that Si(111) surface functionalized with 1/3 monolayer of halogen atoms [Si(111)-$\sqrt{3} \times \sqrt{3}$X (X=Cl, Br, I)] exhibiting a trigonal superstructure, provides an ideal template for epitaxial growth of heavy metals, such as Bi, which self-assemble into a hexagonal lattice with high kinetic and thermodynamic stability. Remarkably, the Bi overlayer show the feature of a (p_{x}, p_{y}) analogue of graphene that exhibits quantum spin Hall state with an energy gap as large as $\sim$ 0.8 eV. Growth of transition metals lead to the discovery of a new 2D material, sd^2 graphene, characterized with bond-center electronic hopping, which surprisingly transforms the atomic hexagonal lattice into a hidden kagome lattice and exhibits a wide range of topological quantum phases. For example, quantum anomalous Hall states can be realized in W@Si(111)-$\sqrt{3} \times \sqrt{3}$-Cl, with an energy gap of $\sim$ 0.1 eV. These findings may pave the way for future exploration of Si-based topological quantum phases, by exploiting epitaxial growth and current available semiconductor technology. This research was supported by DOE (Grant No: DEFG02-04ER46148).

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