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Single-Valley Engineering in Graphene Superlattices YAFEI REN, XINZHOU DENG, Univ of Sci & Tech of China, CHANGSHENG LI, Hunan Univ of Art & Sci, JEIL JUNG, Nat Univ of Singapore, CHANGGAN ZENG, ZHENYU ZHANG, Univ of Sci & Tech of China, QIAN NIU, Univ of Texas at Austin; Peking Univ, ZHENHUA QIAO, Univ of Sci & Tech of China — The two inequivalent valleys in graphene preclude the protection against inter-valley scattering offered by an odd-number of Dirac cones characteristic of Z_2 topological insulator phases. Here we propose a way to engineer a chiral single-valley phase in a honeycomb lattice via folding K and K′ valleys onto Γ point in tailored $\sqrt{3}N \times \sqrt{3}N$ or $3N \times 3N$ superlattices. The corresponding effective Hamiltonians for top-site adatom adsorption leads to inter-valley coupling and valley-orbit coupling mechanisms that resemble the conventional in-plane Zeeman fields and spin-orbit coupling of the electron spins that have important implications in valleytronics to control the valley polarization coherently. By folding the inequivalent K and K′ valleys together, the single valley phase can be formed and engineered by the the inter-valley coupling and staggered sublattice potentials from inversion symmetry breaking. A topological phase transition can take place from the quantum valley-Hall phase at large staggered sublattice potential to a chiral single-valley phase with quadratic band crossover resembling the electronic structure of one *half* AB-stacked bilayer graphene for sufficiently strong inter-valley coupling.

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