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Topological insulator gap in graphene with heavy adatoms

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It is important to search an effective approach to expand the spin-orbit coupling gap of graphene for the realization of the two-dimensional topological insulator (TI) state. We found that heavy In or Tl adatoms may dramatically enhance the gap to detectable values of order 7 or 20 meV, large enough for the realization of quantum spin Hall effect in experimental conditions. However, In and Tl atoms may easily coalesce on graphene due to their weak binding energies and shallow segregation barriers. We proposed a new way to produce a two-dimensional spin-orbit coupling gap using the impurity bands that are mediated through graphene. First principles calculations predict that the gaps generated by osmium and iridium exceed 200 meV over a broad range of adatom coverage The position of the Fermi level can be manipulated by using external electric field and co-adsorbates. The mechanism at work is expected to be rather general and may open the door to designing new TI phases in many materials.

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