DECORATING NANOCLUSTERS ON INORGANIC LAYERED CRYSTALS

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Benefiting from inner- and inter-layer structures and nonzero bandgaps, the inorganic layered crystals (ILCs) have been found as emerging semiconductors advancing in the state-of-the-art nanoelectronic devices, yet become ones of research focuses in materials science. Manipulations and understandings of ILC properties are crucial to boost their applications. However, due to material dimensional and structural natures, challenges remain within material engineering and characterizations. [1]

Herein, we review recent progresses of manipulating the ILC properties through introducing nanoclusters or nanoparticles to the layered hosts. The review debuts from experimental evidences of nanopartile roles in the ILC manipulations, continues with first-principles predictions of t materials properties, and ends up in outlooks in joining explorations of theoretical and experimental works within such a domain.

By anchoring the gold nanoparticles on the typical ILC MoS_2 flakes, it was found that excitonic transitions of stacks were substantially prompted. The doped ILC has a similar excitonic behavior as the doped-Si wafers, referring potential applications in wide ranges similar as group IV materials. [2] Inspired with this finding and based on reliable first-principles calculations of the MoS_2 properties [3], we carried out theoretical modellings on the ILCs decorated with other functional nano-dopants. The magnetism is enabled in stable MoS_2 pizzas and sandwiches with Mn_n (n = 1–4) cluster toppings and fillings. Direct bandgaps were found in the Mn_n@MoS_2(M) (n = 1,4) pizzas, and excitingly in the Mn_1@MoS_2(B) sandwich. This route shows a novel material manipulation strategy via combining functional clusters to the layered hosts. [4] Different from the organic LC of graphene, most of the ILCs are in compound forms. Doping with their component elements and element clusters can also lead to distinct materials properties. A case study shows that the monolayer MoS_2 is turned to magnetic semiconductor just by introducing the Mo clusters. [5]

Despite of the above achievements, however, questions still remain in the ILCs doping level, contact modes with metals, and electronic structures leading to their unique properties. It is hoped that through the present review, more awareness can be attracted from materials and physics societies.

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