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A photofunctional bottom-up bis(dipyrrinato)zinc(II) complex nanosheet

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Two-dimensional polymeric nanosheets have recently gained much attention of scientists. Particularly, top-down nanosheets such as graphene, metal oxides, metal dichalcogenides, and metal hydroxides that originate from bulk layered mother materials are regarded as promising nanomaterials for applications in electronics, photonics and spintronics. Another type of nanosheets, namely molecule-based bottom-up nanosheets, is emerging. A significant advantage of the bottom-up synthesis is that structures can be customized at will through the selection of components (for example, metal ions and organic ligand molecules). Therefore, the bottom-up approach may broaden the diversity and utility of nanosheets. Although previous reports on bottom-up nanosheets have concentrated on the fabrication and analysis of various two-dimensional structures, no functionality has been demonstrated thus far.

Here, the author shows the design and synthesis of a bottom-up nanosheet featuring a photoactive bis(dipyrrinato)zinc(II) complex motif. A liquid/liquid interfacial synthesis between a threeway dipyrrin ligand and zinc(II) ions results in a multi-layer nanosheet with large domain sizes. On the other hand, an air/liquid interfacial reaction produces a single-layer or few-layer nanosheet with domain sizes of >10 mm on one side. These synthetic procedures are distinct from conventional one-phase reactions, which in this case result in disordered solids. The bis(dipyrrinato)zinc(II) metal complex nanosheet is easy to deposit on various substrates using the Langmuir–Schäfer process. The Langmuir–Schäfer process also affords quantitative layering of the single-layer nanosheet. The nanosheet deposited on a semiconductive transparent SnO_2 electrode functions as a photoanode in a photoelectric conversion system, and is thus the first photofunctional bottom-up nanosheet.

Keywords: nanosheet; bottom-up; dipyrrin; coordination compound