The electronic properties of semiconductor monolayers such as transition metal dichalcogenides (TMDs) have attracted interest for a variety of device applications. However, exploiting monolayers technologically is complicated by the strict requirement for physical isolation.

Here, we report the synthesis, characterization, and electronic structure of a semiconductor that retains 2D electronic properties in the bulk. Silver benzeneselenolate, $[\text{AgSePh}]_\infty$, is an air-stable metal-organic crystal comprised of ultrathin silver selenide layers, decoupled by covalently linked organic spacers.

This material:

...self-assembles in one step from small-organic building blocks at ambient temperature and pressure,

...is a direct band gap semiconductor with intense blue fluorescence at 467 nm,

...and requires no physical exfoliation to exhibit its 2D properties.

Ab initio calculations confirm that the layers in the bulk crystal are direct band gap semiconductors and electrically isolated. Furthermore, ab initio calculations show that ligand design may present opportunities for manipulating the optoelectronic properties of a new class of hybrid vdW solids, the metal-organic chalcogenide assemblies.