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Only a few of the vast range of potential two-dimensional materials (2D) have been isolated or synthesised to date. Typically, 2D materials are discovered by mechanically exfoliating naturally occurring bulk crystals to produce atomically thin layers, after which a material-specific vapour synthesis method must be developed to grow interesting candidates in a scalable manner. Here we show a general approach for synthesising thin layers of two-dimensional binary compounds. We apply the method to obtain high quality, epitaxial MoS₂ films, and extend the principle to the synthesis of a wide range of other materials—both well-known and never-before isolated—including transition metal sulphides, selenides, tellurides, and nitrides. This approach greatly simplifies the synthesis of currently known materials, and provides a general framework for synthesising both predicted and unexpected new 2D compounds.

General information
Publication status: Published
Organisations: Department of Physics, Center for Nanostructured Graphene, Department of Photonics Engineering, Structured Electromagnetic Materials, Experimental Surface and Nanomaterials Physics, Aarhus University, National University of Singapore
Corresponding author: Booth, T. J.
Number of pages: 7
Publication date: 2019
Peer-reviewed: Yes

Publication information
Journal: Nature Communications
Volume: 10
Issue number: 1
Article number: 2957
ISSN (Print): 2041-1723
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
Original language: English
Electronic versions:
s41467_019_11075_2.pdf
DOIs: 10.1038/s41467-019-11075-2
Source: FindIt
Source-ID: 2450539637
Research output: Contribution to journal › Journal article – Annual report year: 2019 › Research › peer-review