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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.

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