

# Salt-assisted direct exfoliation of two-dimensional materials into high-quality, few-layer sheets

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## Abstract

In the past years, extensive attention has been drawn to graphene, a flat monolayer of carbon atoms hexagonally arranged into a honeycomb lattice, owing to its exceptional properties in electronics, optics and mechanics. Encouraged by this research bloom, much exploration has been devoted to other 2D materials, such as transition metal dichalcogenides (TMDs), which have layered bulk crystals analogous to graphite. Currently, a variety of fabrication and characterization techniques have been utilized to investigate the single- and few-layer 2D sheets, which exhibit outstanding performance in a wide range of applications.

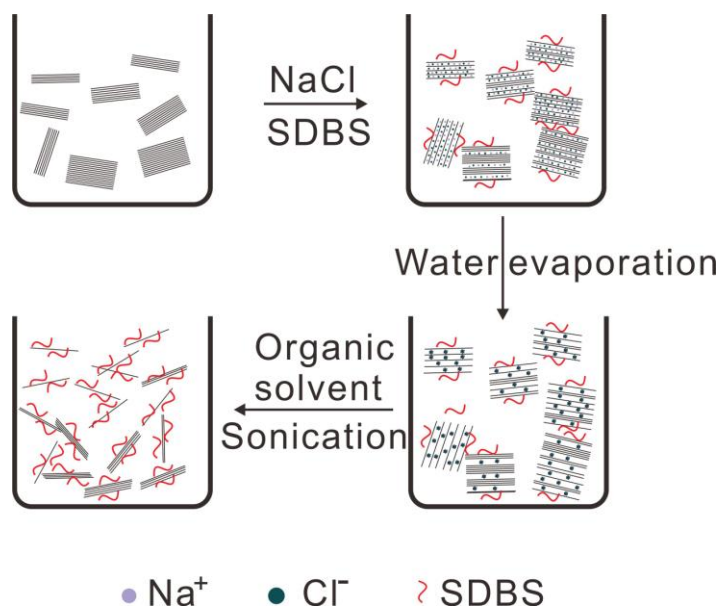
One key priority of the research front is the development of synthetic approaches that allow cost effective mass-production of high-quality, few-layer 2D sheets. However, previously reported methods suffer some inevitable disadvantages, such as the low throughput for mechanical exfoliation, harsh condition requirements for CVD method, and the presence of large amount of defects in chemical synthesis. The liquid-phase ultrasonic exfoliation has the potential to not only give mass production with good quality but also offer convenience for the solution processing.

Here we report a facile and low-cost approach to directly exfoliate two-dimensional materials such as graphite and TMDs powders into high-quality, few-layer sheets. In this method, aqueous mixture of 2D materials and inorganic salts such as NaCl and CuCl<sub>2</sub> are stirred together, and subsequently dried by evaporation. Finally the mixtures are dispersed into an orthogonal organic solvents solution of the salt by low-power and short-time ultrasonication, which can exfoliate 2D bulk materials into few-layer sheets. Typical characterizations such as TEM, Raman, AFM and XRD are carried out, which present some promising results by using this method. Those sheets can be readily dispersed into aqueous solution in the presence of surfactant and thus is compatible with various solution-processing techniques towards thin film devices.

## References

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## Figures



**Figure 1.** Schematic illustration of the synthesis of few-layer 2D materials by salt-assisted direct exfoliation.