

# Defence of a Doctoral Thesis

## Liquid-phase exfoliation of two-dimensional materials

Applications, deposition methods and printed electronics on paper

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Doctoral Thesis in Chemical Engineering

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### Abstract

After the unprecedented success of graphene research, other materials that can also be exfoliated into thin layers, like transition metal dichalcogenides (TMDs) such as molybdenum disulfide ( $\text{MoS}_2$ ), have also become the subjects of extensive studies. As one of the most promising methods for large scale production of such materials, liquid-phase exfoliation (LPE) has also been the subject of extensive research and is maturing as a field to the point that devices using additive manufacturing and printed nanosheets are often reported. The stability of the nanosheets in environmentally friendly solvents, particularly in water, with or without stabilizers, is still a focus of great interest for sustainable and commercial production.

In this thesis, different methods of LPE in water with and without stabilizers are investigated and discussed. Stabilizers such as surfactant sodium dodecyl sulfate (SDS) and modified cellulose 2-hydroxyethyl cellulose (HEC), were employed. Because water does not have surface energy parameters that match those of 2D materials, the dispersions in water do not usually have a high yield. Therefore, to circumvent the use of organic solvents that are known to be able to successfully exfoliate and stabilize nanosheets of two-dimensional materials, this thesis focuses on water as the solution-process medium for exfoliation and the assisting stabilizers used to keep the exfoliated nanomaterials in dispersion with a long shelf life. Read the whole abstract on the website [www.miun.se/fscn](http://www.miun.se/fscn).



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**Welcome!**