Use of deep learning in experimental characterization of 2D materials

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Abstract

The study of two-dimensional (2D) materials is new and vibrant research field of interest. Electronic, mechanical and optical properties of such materials are significantly different compared to their respective three-dimensional allotropes due to reduction of their dimension, from bulk down to the atomic thickness. Owing to such exciting properties, these materials hold a great potential for use in various fields of electronics. However, to exploit the benefits which these properties offer, there is a need for controlled synthesis and rapid characterisation of sample properties and quality.

The first step in characterisation of synthesized materials typically consists of morphological analysis. Morphology can hold a lot of information about various physical and chemical properties of a certain material, including crystallinity and, specific to 2D materials, number of layers. This kind of characterisation is usually done visually and qualitatively by experienced researches, or quantitatively over very long periods of time.

Deep learning is a rapidly growing field of research, mainly focused on the automated development of statistical analysis methods and models by direct learning from data and observations. It is usually associated with the development of artificial intelligence and used in more technical fields (for example robotics and machine control). However, many scientific fields, specifically biology and medicine have been quick to introduce deep learning as a tool for accelerating numerical calculations, knowledge discovery and analysis of experimental data.

In this seminar we will discuss the typical workflow of 2D sample synthesis and characterisation, focusing mainly on atmospheric CVD synthesis and mechanical exfoliation. We will discuss some of the work that resulted in successful application of deep learning approaches to 2D material characterisation in relation to the synthesis workflow. Additionally, by comparison to approaches in other fields of research, we will consider the potential future work and new use-cases of deep learning in experimental 2D material science.

References

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