

Processing and applications of two-dimensional nanosheet inks

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Liquid phase exfoliation has been proved to be a cheap, scalable method for the mass production of 2D sheets. This talk will first discuss the galaxy of existent layered materials, with emphasis on synthesis, liquid-phase exfoliation, and characterization, focussing on some key applications recently developed in our laboratories, ranging from energy storage to printed electronics. We will for example discuss how two-dimensional Ti_3C_2 (MXene) can be formulated in aqueous and organic viscous inks for extrusion printing and inkjet printing, respectively, and demonstrate direct MXene printing on various substrates. The additive- and binary solvent-free MXene inks do not show coffee ring effect, enabling high-resolution printing without substrate pre-treatment. The resulting all-MXene printed micro-supercapacitors showcase excellent charge storage performance, including areal capacitance up to 43 mF/cm^2 and volumetric capacitance up to 562 F/cm^3 in protic gel electrolyte, coupled with long lifetime and good flexibility. We also show examples of all-inkjet-printed MXene arrays for ohmic resistors. The versatile direct-ink-printing technique highlights the promise of MXene functional inks for scalable fabrication of easy-to-integrate components of printable electronics. We will also discuss how MXenes can be used as a conductive binder for silicon electrodes produced by a simple and scalable slurry-casting technique without the need of any other additives. The nanosheets form a continuous metallic network, enable fast charge transport and provide good mechanical reinforcement for the thick electrode (up to $450 \mu\text{m}$). Consequently, record high areal capacity anodes (up to 23.3 mAh cm^{-2}) can be demonstrated. EMI shielding applications will also be discussed.

Figures

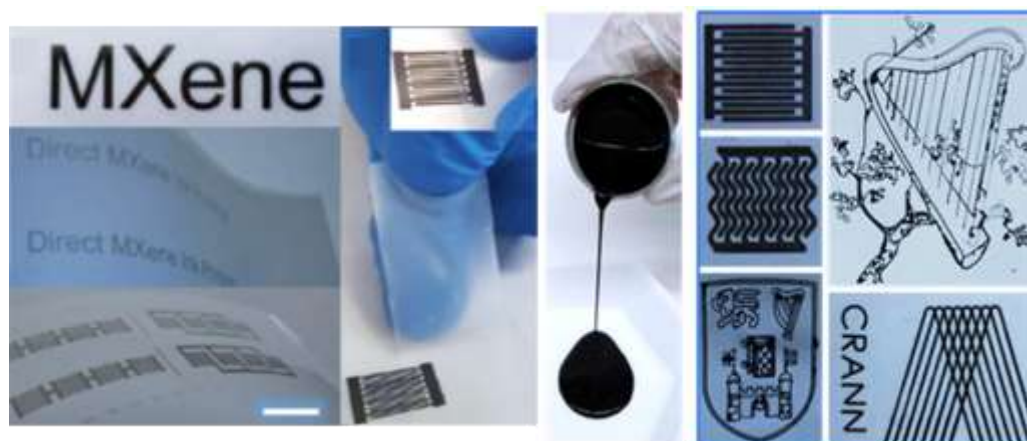


Figure 1: Printed devices based on MXenes inks