Functionalized MXene Inks for High-Resolution Printing of Micro-Supercapacitor Electrodes

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Solution-based processing offers a sustainable and cost-effective alternative to traditional lithographic methods for fabricating functional materials [1]. Among printing techniques, electrohydrodynamic (EHD) jet printing stands out for its ability to handle diverse ink viscosities and achieve high-resolution patterning [2].
In this work, we address key challenges of MXenes, known for their high conductivity but limited by oxidation and poor dispersion in organic solvents [3-4]. Through functionalization, we developed stable MXene dispersions with ~1 μm flake size, blended with tailored binders in a hybrid solvent to create a stable MXene-based ink. The ink exhibited excellent conductivity, oxidation resistance, and dispersion stability for over three months, with a viscosity (~4×10^3 cP) optimized for EHD printing.
Using this ink, we fabricated interdigitated micro-supercapacitor electrodes with 80 μm width and spacing, achieving an areal density of 6 cells cm^{-2}. The electrodes delivered outstanding performance, with areal and volumetric capacitances of 402.7 mF/cm^2 and 805 F/cm^3, respectively. Density functional theory (DFT) calculations highlighted the synergistic roles of the functionalization agent and binder in enhancing oxidation resistance and dispersion stability. This study advances MXene-based inks for high-performance electronics, demonstrating a scalable and precise manufacturing route for energy storage devices.

References

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Figures

Figure 1: MXene microchip fabricated via EHD printing with ADOPA-functionalized MXene