# Ti-based MXenes as Emerging 2D Materials for High-Performance Supercapacitor Applications

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## Abstract

Two-dimensional (2D) materials play a crucial role in advancing next-generation energy storage technologies due to their high surface area, tunable electronic properties, and structural flexibility. Among emerging 2D materials, Ti-based MXenes have gained increasing attention as a complementary alternative to graphene, offering metallic conductivity and rich surface chemistry for electrochemical applications. This presentation reports systematic engineering of $Ti_2CT_x$ and $Ti_3C_2T_x$ MXenes to enhance their performance as supercapacitor electrodes. Post-synthesis thermal treatments under controlled atmospheres were employed to tailor surface terminations and optimize charge storage behavior. To mitigate layer restacking and introduce additional pseudocapacitive contributions, MXenes were integrated with transition metal oxides ($MnO_2$, CuO, and $Fe_3O_4$) and conducting polymers (polyaniline and polypyrrole), forming advanced 2D hybrid architectures. The resulting hybrid electrodes exhibited significantly improved capacitance, energy density, and long-term cycling stability compared to pristine MXenes. The practical potential of these materials was further demonstrated through screen-printed micro-supercapacitors, which delivered high areal capacitance, mechanical flexibility, and stable operation. Overall, this talk highlights MXene-based 2D hybrids as scalable, high-performance electrode platforms within the broader landscape of graphene and emerging 2D materials for sustainable energy storage.

References

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Figures

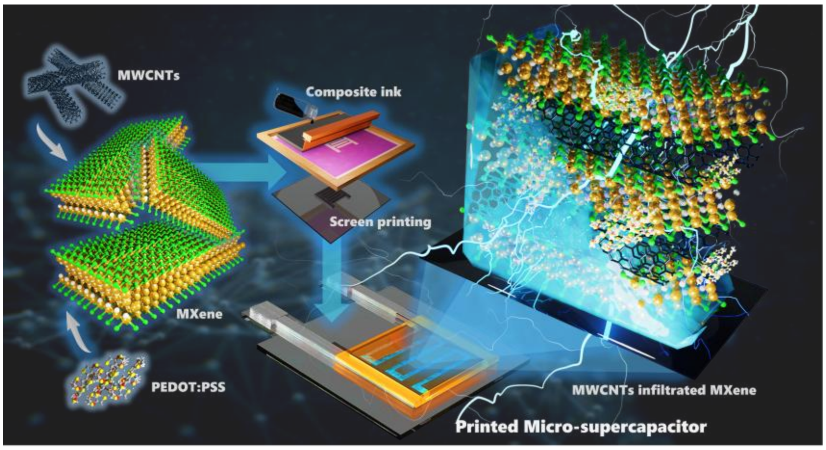


**Figure 1:** MXene-based printed micro-supercapacitor