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ADDITIVE MANUFACTURING OF TWO-DIMENSIONAL INKS FOR IN-SPACE MANUFACTURING OF ADVANCED SENSORS AND ENERGY STORAGE

Abstract

Additive electronics manufacturing is a promising technique for designing lightweight electronic devises including sensors and energy storage devices, with complex geometries and low processing costs, However, the field is constrained by the lack of multifunctional nanomaterial inks, and selection of the material is a crucial step of the process, as the performance of the printed device is strongly dependent on the design, material, printing method, and post printing process. For example, tailoring metal work function of printed metals is critical in achieving low contact resistance to semiconductor films, while tuning band gap, piezoelectricity, and pseudo capacitance of printable inks can open up new applications in printed radiation sensing, electromagnetic shielding, and energy harvesting and storage devices. Here we summarize our efforts in developing, synthesizing, characterization, and formulating ternary transition metal dichalcogenides (TMDs) alloy and transition metal carbide (MXene) inks for additive electronic manufacturing techniques of energy storage devices. Chemical wet etching and ball-milling-assisted liquid phase exfoliation techniques are utilize for synthesizing high-quality nanomaterials. The resultant nanomate-

rials are developed into nanomaterial inks compatible with various additive manufacturing techniques, including, aerosol jet printing, plasma jet printing, ink jet printing, and spray coating. Detailed analysis of the material characterization, ink properties, and printing parameters for multiple printer modalities are required to optimize the fluid dynamics and properties of the inks. Various post-printing process techniques such as annealing under inert is employed for printed nanomaterials inks in order to achieve bulk-like performance for the printed structures. Our results highlight the innovations in synthesis and formulation of advanced nanomaterial inks for multiple printer modalities and the development of energy storage devices and sensors.