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Thermodynamically Guided Assembly of MXene-Microgel for Multifunctional Hybrid Soft Materials

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Abstract Text:
Multifunctional composites featuring embedded responsiveness are a promising area in advanced materials. This work presents an approach to formulate customizable and multifunctional hybrid soft materials by leveraging the properties of $Ti_3C_2T_x$ MXene nanosheets. By configuring jammed microgels as colloidal templates, conductive MXene alignments are directed in low 2wt% suspensions, simultaneously preventing aggregation and imparting viscosity for shape retention during extrusion fabrication.

The resulting MXene-based ink exhibits notable rheological properties, with viscosities up to 50,000 Pa-s and yield stress over 400 Pa. The gel 3D structural is preserved through freeze-drying, yielding aerogels with 99% porosity and resilience exceeding 5000x compression loading without the need for supplemental processing. The hybrids achieve an electrical conductivity of 360 S/m and electromagnetic interference shielding of 57dB, attributed to the percolated conduction network formed by the aligned MXene nanosheets, even at low densities.

Characterization reveals that the performance enhancements stem from favorable interfacial interactions between $Ti_3C_2T_x$ MXene and microgels, which spatially confine the nanosheets into networks while preventing uncontrolled aggregation. This thermodynamically guided assembly approach allows for combinations of properties by stabilizing conductive alignments in extrusion-amenable precursors,

with the structural order translating to enhanced solid-state functionality.

The developed MXene-based hybrids demonstrate the potential for embedding multiple functionalities, such as mechanical responsiveness, electronic properties, and electromagnetic shielding, within a single material system.

Session Selection:
Advanced Hybrid Material
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