Design and Development of Functional Materials: Case Studies on Solvent-Free Organic Liquids and Nonplanar Nanographenes

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Abstract:

The rational design of functional materials with tunable (chiro)optoelectronic properties is central to advancing next-generation technologies in optoelectronics, energy storage, and soft electronics. Solvent-free organic liquids (SOLs), composed entirely of functional molecular units, offer unique advantages, including enhanced processability, intrinsic fluidity, and the elimination of volatile solvents, making them attractive for sustainable and flexible material applications.[1] Through molecular engineering of intermolecular interactions and steric architecture, we demonstrate how viscosity, thermal stability, and optoelectronic properties can be precisely controlled. Interestingly, a polymerizable SOL enabled the development of large-area, flexible, foldable, and stretchable luminescent thin films.[1]

In parallel, nanographenes provide a versatile platform for tailoring electronic structure through edge topology, π-conjugation, and heteroatom incorporation. By modulating molecular geometry and electronic coupling, we explore structure–property relationships governing excited-state behavior, charge transport, and photophysical responses.[2] The innovative strategies for the design and development of functional materials, focusing on two emerging classes: solvent-free organic liquids and nonplanar nanographenes, will be discussed.

References

1. *Acc. Chem. Res.* **2024**, *57*, 670-684.; *Angew. Chem. Int. Ed.* **2023**, *62*, e202307381.

2. *Angew. Chem. Int. Ed.* **2025**, *65*, e202422125; *Angew. Chem. Int. Ed.* **2025**, *64*, e202420767; *Angew. Chem. Int. Ed.* **2023**, *62*, e202311657.