

Nanoscience meets liquid crystals: A review of functional hybrids and their game-changing applications

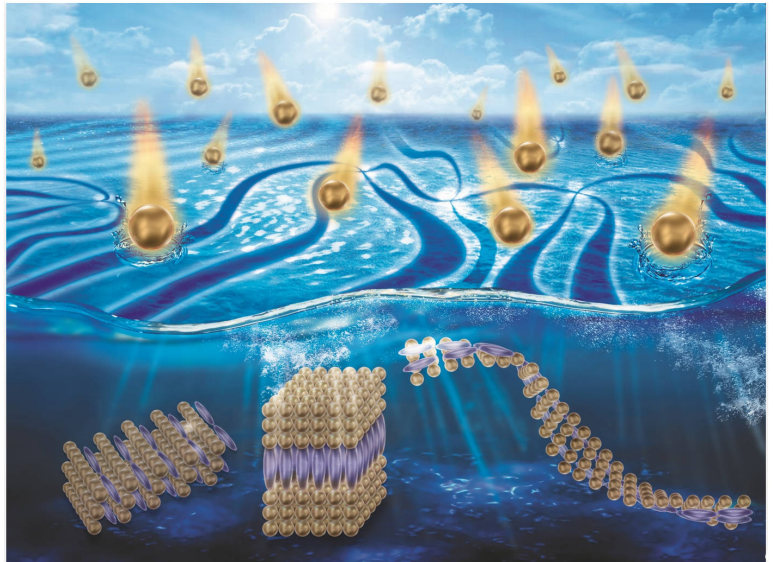
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/EINPresswire.com/ -- This review assesses the state-of-the-art of functional [liquid crystals](#) with nanomaterials, including self-organized alignment enabled by nanotechnology, diverse properties of nanoparticle-doped systems, soft actuators and tunable structural color in nanohybrid elastomers, and provides critical perspectives on comparative advantages and remaining challenges.

Most people know liquid crystals (LCs) from their displays, but they are actually a fascinating state of matter – fluid like a liquid, yet ordered like a crystal. When bringing nanoscience into the picture, LCs become much more than display materials. A review in *Advanced Nanocomposites* offers a state-of-the-art assessment of the rapidly evolving intersection between LCs and nanoscience. The authors present how the marriage of these two fields is not just an incremental advance, but a paradigm shift, enabling the design of advanced multifunctional, programmable, and reconfigurable materials.

The review provides new insights into the opportunities and challenges presented by these advanced functional architectures. The authors believe it offers a vital resource for researchers and serves as a roadmap for future innovations in physics, chemistry, materials science, biology, and engineering.

"LCs can serve as a programmable 'canvas' that guides nanoparticles – gold, graphene, MXene – to self-assemble in precise ways," explains lead and corresponding author Jian Sun, a researcher in Zhejiang Key Laboratory of Soft Matter Biomedical Materials at Wenzhou Institute, University of Chinese Academy of Sciences. "Those nanoparticles, in return, give LCs entirely new abilities:



THE MARRIAGE OF LIQUID CRYSTALS WITH NANOSCIENCE.

photothermal response, color switching, encryption, even muscle-like movement. It's a true synergy, and it opens the door to a new generation of smart, reconfigurable materials.

The review focused on three areas.

Alignment control: using 2D materials like graphene or engineered nanoparticles, uniform LC alignment without traditional rubbing or photo-treatment can be achieved, and with the possibility of tuning it remotely with light or fields.

Nanoparticle-doped LCs: LC templates can modulate plasmonic, fluorescent, and self-assembly properties of nanoparticles, while nanoparticles can stabilise blue phases, reduce operating voltages, and enable tunable metasurfaces.

LC elastomers (LCEs): By incorporating photothermal nanomaterials such as MXene, carbon nanotubes, or gold nanorods, LCEs become soft actuators that bend, crawl, and even walk on water, mimicking natural muscles.

"Additionally, we highlighted how functional nanomaterials enable tunable structural color in chiral LCEs for advanced anti-counterfeiting, adaptive camouflage, and dynamic information encryption," adds Sun.

Nonetheless, the researchers summarized three major hurdles in achieving:

Stability: nanoparticles must remain well-dispersed and the composites must withstand repeated cycling without degradation.

Scalability: translating these precise, often custom-made, materials into cost-effective, large-area manufacturing.

Multifunctional integration: the next frontier would be actuators that sense, move, and change color simultaneously all in one system.

References

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