Materials & Chemicals

High-Symmetry, Bicontinuous Lyotropic Liquid Crystals with Percolating Nanoscale Domains

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WARF: P120009US01

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing high-symmetry, bicontinuous lyotropic liquid crystals.

Overview

Liquid crystals, soft materials comprised of assemblies of organic molecules that exhibit long-range order at the five to 100 nanometer length scale, find widespread application in consumer goods ranging from television displays to personal care items such as soaps and shampoos. Lyotropic liquid crystals (LLCs) are a subclass of these materials based on the spontaneous nanoscale self-assembly of amphiphilic molecules upon addition of a polar solvent. LLCs exhibit a wide variety of nanostructures that naturally lend to their application in the areas of therapeutic drug and nucleic acid delivery, protein crystallization and inorganic materials templating. Many of these applications critically hinge on the ability to form high-symmetry LLC nanostructures having ordered, interpercolating polar and nonpolar pores with cubic symmetries (Q-phases).

Yet these highly symmetric structures, exemplified by the gyroid (G) LLC phase, are difficult to access due to their occurrence over only limited temperature ranges and narrow LLC composition phase windows. Innovative LLC systems capable of robustly forming Q-phases would allow for wider application of these useful soft nanomaterials.

LLCs based on molecules that are dimers of traditional small molecule amphiphiles, possessing two hydrophilic head groups and two hydrophobic tails joined at or near the head groups, are of particular interest. These so-called “Gemini” amphiphiles form a wide variety of LLC structures depending on their concentration in a polar solvent, temperature and pressure. At intermediate concentrations, Gemini amphiphiles readily self-assemble in polar solvents to form useful Q-phases.

The Invention

UW–Madison researchers have developed a new class of anionic Gemini amphiphiles based on aliphatic carboxylic acids that exhibit a strong propensity to form G-phase LLC assemblies in an aqueous solution. Moreover, these G-phases are broadly stable between 25 and 100 degrees Celsius and across a wide range of amphiphile concentrations (up to 20 weight percent).

The LLC-forming material comprises water or another polar solvent and an anionic Gemini (“twin tail”) surfactant containing at least one carboxylate moiety. This scaffold furnishes ready access to useful, high-symmetry Q-phase LLCs having well-defined pore wall functionalities that can be readily tuned by chemical synthesis for specific applications.

Applications

- Therapeutic drug and nucleic acid delivery
- Protein crystallography

- Biophysical and enzymatic assays
- Templates for mesoporous inorganic materials

Key Benefits

- Ready synthesis of multiply continuous, high-symmetry network morphologies
- Stability across wide temperature ranges and amphiphile concentration windows
- Arbitrary functionalization of surfactants via modular synthetic route

Stage of Development

The development of this technology was supported by WARF Accelerator. WARF Accelerator selects WARF's most commercially promising technologies and provides expert assistance and funding to enable achievement of commercially significant milestones. WARF believes that these technologies are especially attractive opportunities for licensing.

Additional Information

Related Technologies

- For more information about manufacturing lyotropic liquid crystals for the detection of proteins, cells or viruses, see WARF reference number P06005US.

Tech Fields

- Materials & Chemicals : Synthesis

For current licensing status, please contact Jennifer Gottwald at jennifer@warf.org or 608-960-9854