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Well-ordered nanorods could improve LED displays

Scientists have utilized the imaging capabilities of the Cornell High Energy Synchrotron Source (CHESS) to help develop enhanced light-emitting diode displays using bottom-up engineering methods.

Collaborative work between researchers from the University of Florida and CHESS has resulted in a novel way to make colloidal "superparticles" from oriented nanorods of semiconducting materials. The work was published in the journal *Science*, Oct. 19.

The team synthesized nanorods with a cadmium selenide and cadmium sulfide shell. Taking advantage of the compounds' lattice mismatch interfaces, they assembled these rods into larger periodic colloidal structures, called superparticles.

The superparticles exhibit enhanced light emission and polarization, features that are important for fabrication of LED televisions and computer screens. The nucleated superparticles can further be cast into macroscopic polarized films. The films could increase efficiency in polarized LED television and computer screen by as much as 50 percent, the researchers say.

The team, which included CHESS scientist Zhongwu Wang, made use of the CHESS facility to collect small angle X-ray scattering data from specimens inside tiny diamond-anvil cells. They used this technique, in combination with high-resolution transmission electron microscopy, to analyze how nanorods with attached organic components could be formed into well-ordered structures.

The nanorods first align within a layer as hexagonally ordered arrays. Then the highly ordered nanorod arrays behave like a series of layered units, self-assembling into structures that exhibit long-range order as they grow into large superparticles. The elongated superparticles can be aligned in a polymer matrix into macroscopic films.

The project demonstrates how scientists are learning to recognize and exploit anisotropic interactions between nanorods, which can be adjusted during the synthesis process, to create single-domain, needle-like particles. The authors hope their work can lead to new processes of self-assembly to create nano-objects with other anisotropic shapes, perhaps even joining two or more types of objects to form well-defined mesoscopic and macroscopic architectures with greater and greater complexity.

The team was led by Charles Cao, professor of chemistry at the University of Florida. The lead author of the paper was Tie Wang of Cao's group.

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