Supercharged biomacromolecules can maintain their reordered structures induced, for example, by a fingertip touch

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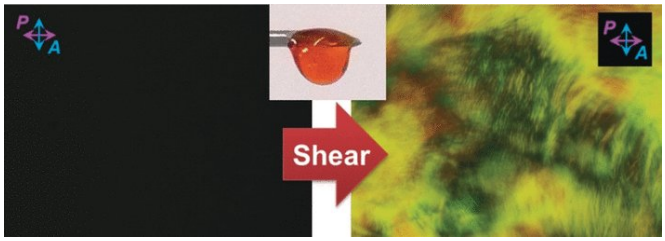

Credit: Wiley

Stimuli-sensitive materials can respond to physical forces with structural phase transitions. This also applies to biopolymer–surfactant mixtures, a study by German and Chinese scientists now reports. Surprisingly, the newly adopted phases persist after removal of the stress and can be detected by a simple optical read-out technology. Biometric fingerprint detection is an attractive application for this technology. The results are published in the journal *Angewandte Chemie*.

Liquid crystals are shape-anisotropic molecules that can adopt distinct ordered phases, depending on the physical conditions. Temperature, pressure, or charge can produce color shifts, dark–light switches, or a birefractive appearance, all of which represent changes in the molecular order. Such transitions can also occur in gels, and even in soaps with micellar transitions. The chemical system developed by Andreas Herrmann at the University of Groningen, the Netherlands, and colleagues at the Chinese Academy of Sciences, is a complex of a supercharged polypeptide with a cationic surfactant. The viscous liquid adopted birefringence patterns after simply being touched, to reveal details such as those of a fingerprint.

Seeking to explore the behavior of biological fluids, the scientists designed a series of supercharged polypeptides that form biological soft materials with interesting properties when paired with molecules supplying the opposite charge. The supercharged polypeptides consisted of five amino acid repeating units with one or two negatively charged glutamic acid residues within each unit. As the cationic surfactant, the researchers designed an aromatic azobenzene with a positive charge on one side and a hydrophobic chain on the other. Added together, the polypeptide and the surfactant formed a water-rich polypeptide liquid droplet with an orange hue. In this liquid the scientists found no molecular order, birefringence, or diffraction pattern, and merely an isotropic viscous fluid.

A shear force stimulated a different response. Flowing water or the touch of a finger made the sample birefringent, and ordered patterns were evident, the authors reported. These ordered structures resembled the long-range lyotropic liquid crystalline phases typical for surfactant-containing mixtures. Surprisingly, that order persisted, even after removing the shear. A polarized optical microscope detected birefringence patterns that sensitively recorded the texture of the shear-applying tool. In other words, the minutiae, the ridges and lines on the fingertip that make up a fingerprint, were well-represented in the polarization micrographs.

This remarkable discovery suggests that the supercharged polypeptide fluid could, in principle, be used for biometric detection. Whereas modern day fingerprint sensors that are not based on ink printing rely on finely adjusted electronics, the scientists present a different setup with microscopic birefringence read-out. However, the exact conditions for the phase transitions in the material and the underlying mechanisms have yet to be explored, the authors remark.

More information: Lei Zhang et al. Genetically Engineered Supercharged Polypeptide Fluids: Fast and Persistent Self-Ordering Induced by Touch, *Angewandte Chemie International Edition* (2018). DOI: 10.1002/anie.201803169

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