Layered nanocomposites by shear-flow-induced alignment of nanosheets

With the support by the National Natural Science Foundation of China, the research team led by Prof. Liu MingJie (刘明杰) at the Key Laboratory of Bioinspired Smart Interfacial Science and Technology of Ministry of Education, School of Chemistry, Beihang University, recently reported an original protocol to layer 2D nanosheets, which overcame the practical difficulties in large-scale preparing layered nanocomposites with remarkable mechanical performances. This work was published in *Nature* (2020, 580: 210—215).

Numerous efforts have been devoted to the development of bioinspired layered nanocomposites. However, it remains a great challenge to produce mechanically strong and tough composites in a universal, viable, and scalable manner for the practical applications. To address this challenge, Liu et al. developed a superspreading layering strategy to overcome the practical difficulties in large-scale preparing ultrastrong nanosheets-based layered nanocomposites. Employing the strong shear-flow during the superspreading process, this strategy enables the alignment of nanosheets at an immiscible hydrogel/oil interface. The aligned nanosheets can be conserved by calcium ions-induced crosslinking of alginate, thus producing nanocomposites with highly ordered layered structures. Importantly, an elegant setup, composed of a continuous system to extend this superspreading process, was developed to produce large-area nanocomposite films with aligned nanosheets. By optimizing the content of nanomaterials and polymers, the nanocomposites revealed the highest mechanical properties to date. The graphene oxide/clay/carbon nanotube-based films have over 1.2 GPa tensile strength and 198 GPa modulus. For the clay/carbon nanotube-based composite films, the fracture toughness can reach 36.7 MJ/m^3. The team identified that the polymers with enhanced glassy state confined between layered nanosheets result in the above outstanding mechanical properties. Moreover, this superspreading strategy can be easily extended to align various nanosheets and could be applied to a wide range of structural composites, offering new opportunities for the development of high-performance composites.

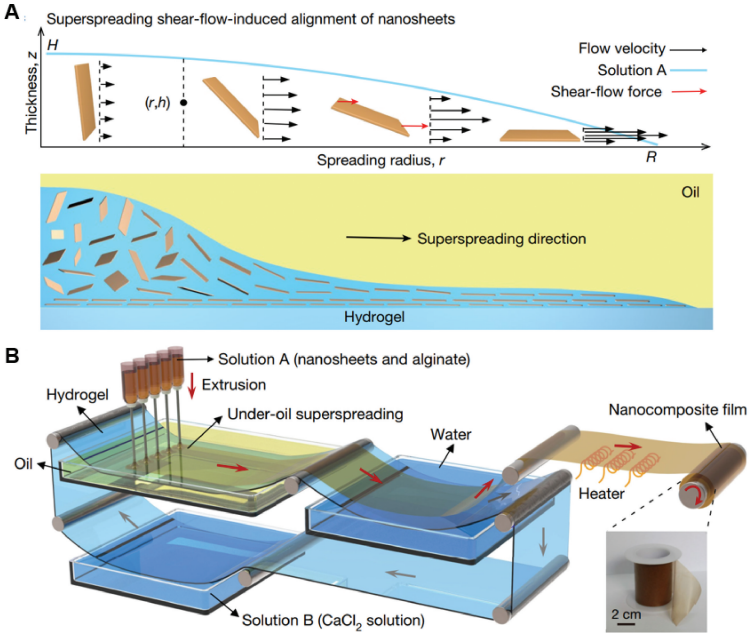

Figure Schematic illustration of the superspreading shear-flow-induced alignment of nanosheets.