탄소섬유의 새로운 트렌드, 그래핀 섬유

융복합섬유팀

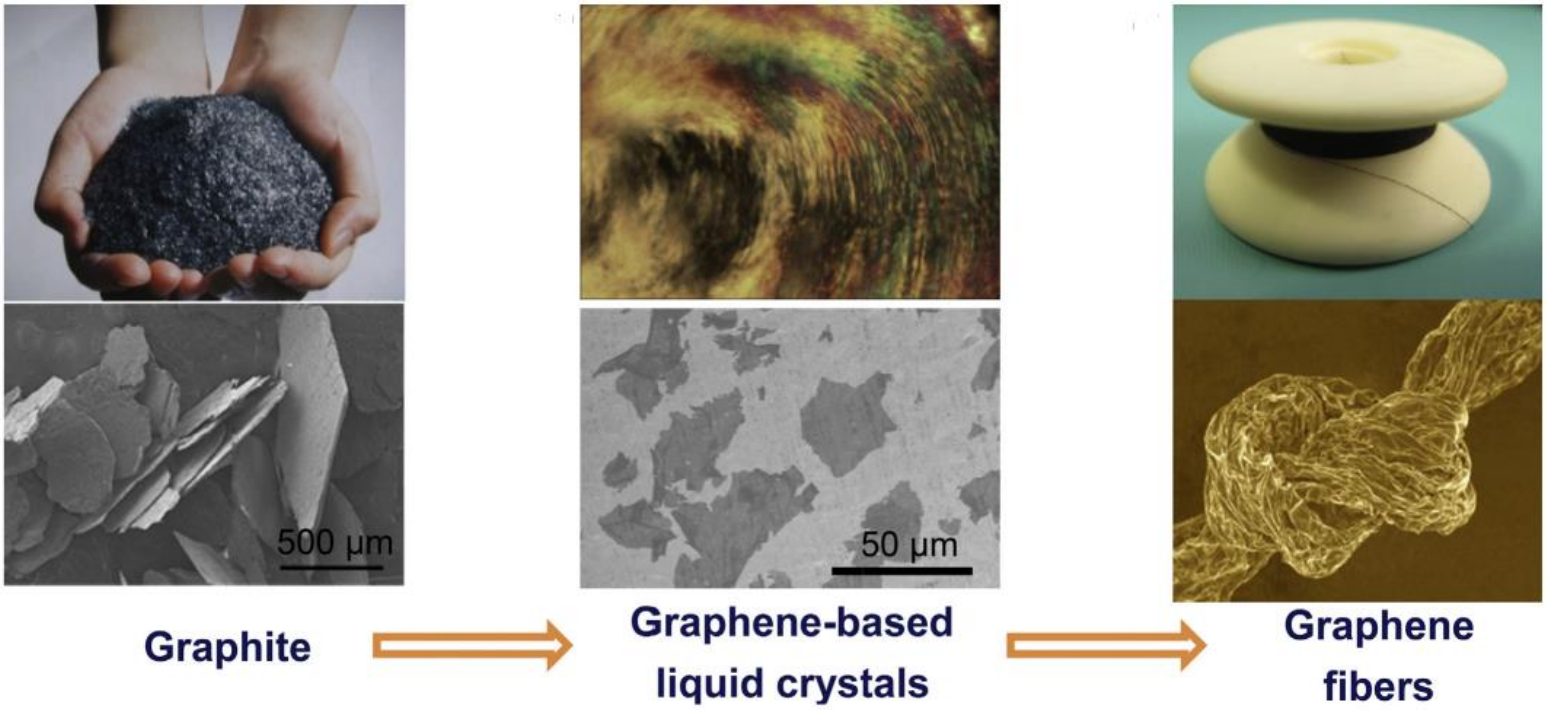
- Because of the intrinsic covalent connection of sp^2 -hybridized carbon atoms, these two carbon crystals have extremely high mechanical strength, up to 130 GPa tensile strength and 1.1 TPa elastic modulus in the case of graphene, together with the valuable flexibility to accommodate deformation and transcendental conductivity for electrical current and thermal flow.

- Graphene is possibly perfect building block for new carbonaceous fibers.

- By contrast to the regeneration of the graphitic structure in the case of conventional CFs, the fabrication of new graphene fibers should rely on the ‘‘bottom-up assembly’’ concept to fashion individual building blocks into an ordered state with atomic precision.

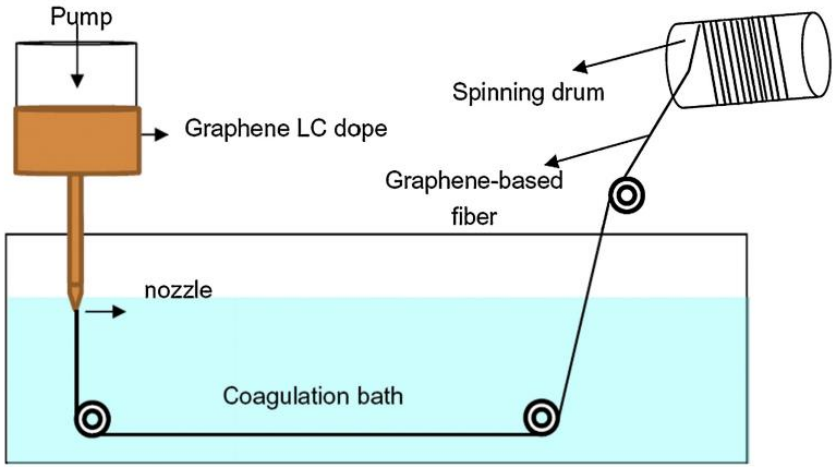
- More importantly, the superior properties of graphene create high expectations for the combined performances of their fibers to catch up and even exceed those of conventional CFs.

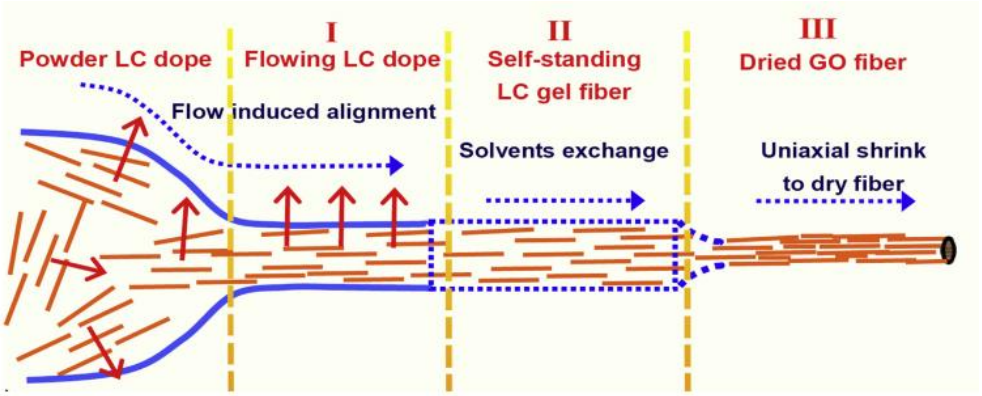
Graphene LC-wet-spinning



- In the first step, graphite crystals are exfoliated to individual graphene sheets, usually by chemical modification.
- The modified graphene sheets form liquid crystals in solvents with orientational or positional order.
- In the second step, wet-spinning assembly is employed to make continuous graphene fibers from these graphene-based liquid crystals, which transform orders from the fluid state to orders in the solid state.

Liquid crystal-based wet-spinning for GF

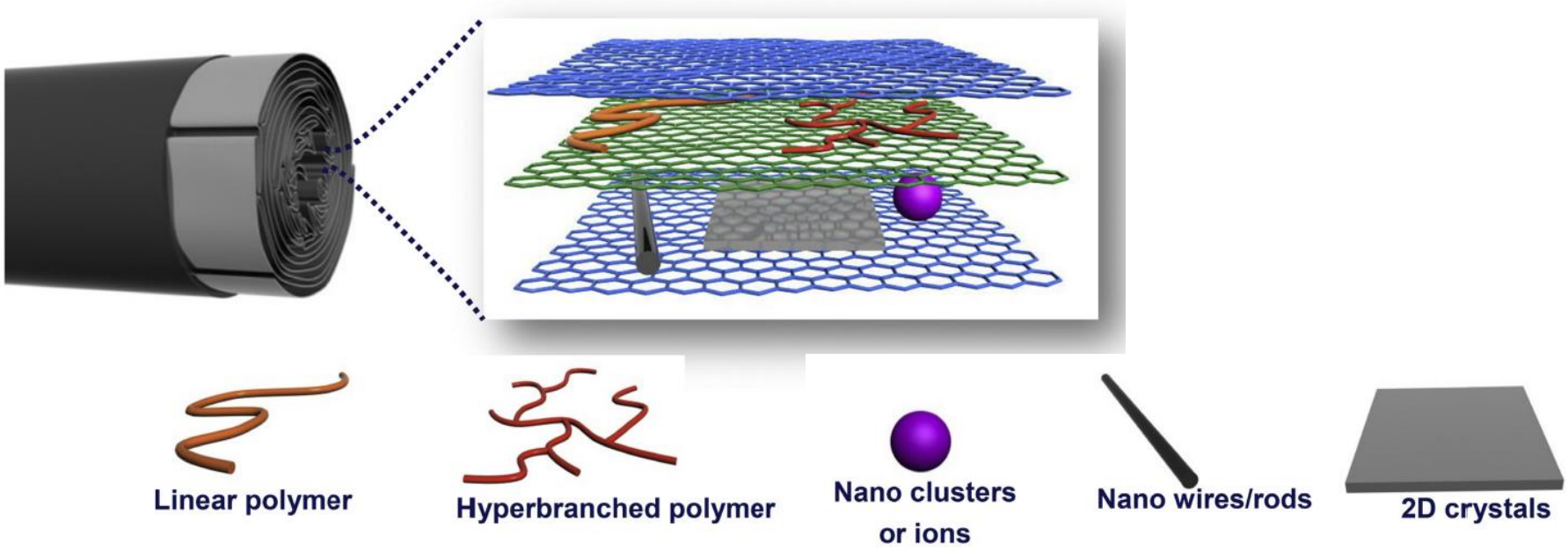




- The schematic wet-spinning process from GO liquid crystals to fibers in a continuous manner.

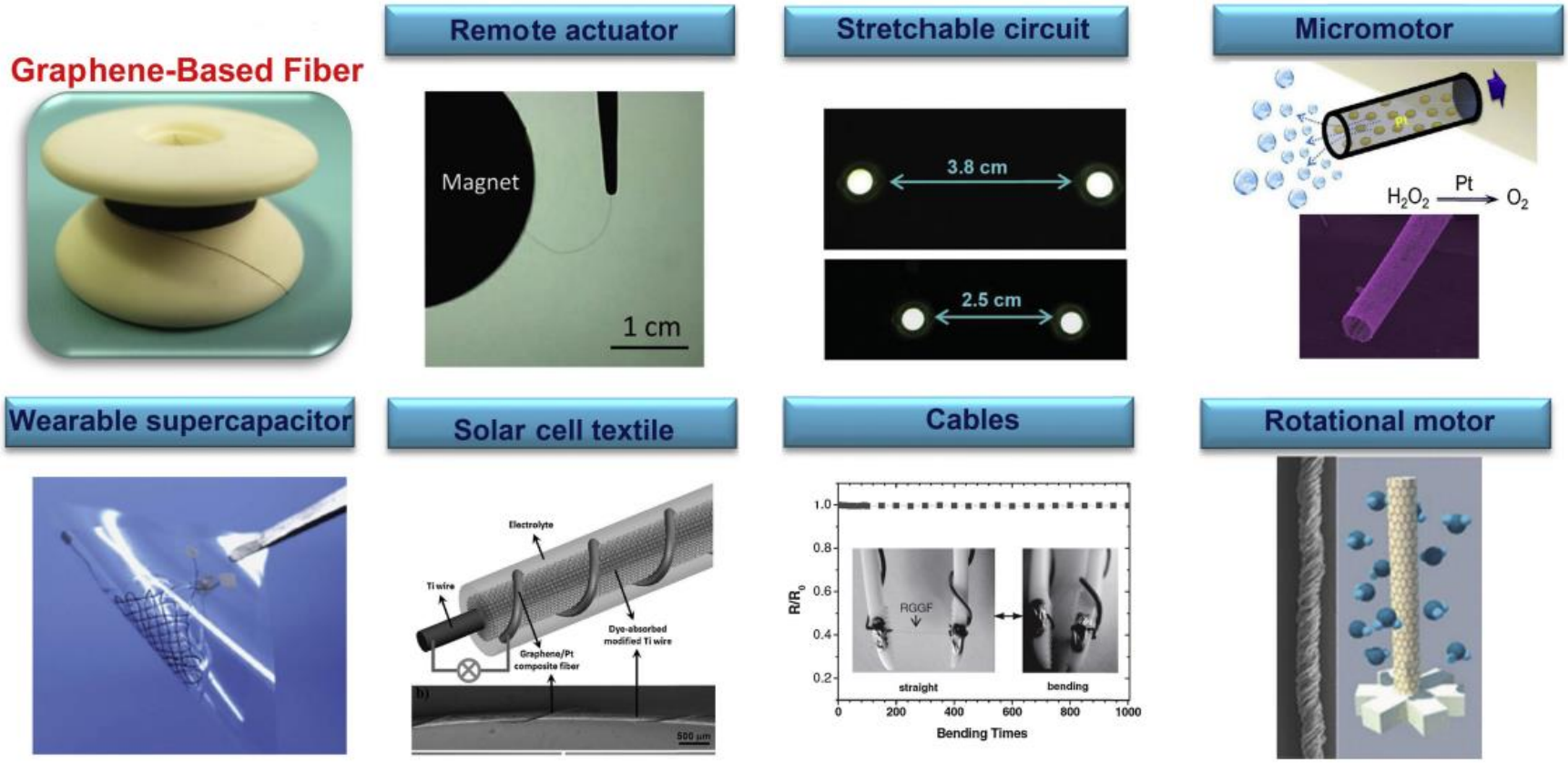
- The structural evolution in the spinning process, which indicates the enhanced alignment process under uniaxial flow during the spinning (Section I), from the powder GO LC with different orientation ordering to the regular alignment of the flowing GO LC dope, GO LC gel fibers (Section II) and final dried GO fibers (Section III).

Composite and hybridized GFs



- Many guests, such as linear and hyperbranched polymers, nano clusters, nano wires/rods, 2D crystals and ions can be introduced into GFs. The graphene composites polymer fibers have nacre-like layered structures and high mechanical strength.
- The family of graphene-based fibers is growing, and mainly encompasses two categories: biomimetic graphene composite fibers and hybridized GFs.

Functional applications of GF



- The high conductivity of GFs makes them good candidates for lightweight electrical conductors such as cables and flexible wires. By tuning the structure of GF and introducing functional guests, GF can perform rich behaviors of actuation, such as rotation motor and remote actuator. Additionally, GFs can be taken as wearable flexible textiles to be used in supercapacitors and solar cells.

Perspectives

- The high conductivity of GFs makes them good candidates for lightweight electrical conductors such as cables and flexible wires. By tuning the structure of GF and introducing functional guests, GF can perform rich behaviors of actuation, such as rotation motor and remote actuator. Additionally, GFs can be taken as wearable flexible textiles to be used in supercapacitors and solar cells.

- Graphene fiber is a new high performance carbonaceous fiber with rich functionalities. The combined properties of GFs have been rapidly promoted to a GPa level of tensile strength and electrical conductivity comparable to conventional CFs, promising a thrilling trend toward higher levels on par with or even exceeding CFs.

- GFs have demonstrated much more impressive rich functional uses than conventional CFs. The functional application of GFs could become pioneering commercial products used in our daily lives, as a typical 1D delegate among forthcoming batches of graphene macroscopic materials.

- The recent advances in GFs have urged us to address the central issue, that is, to upgrade its combined performance, mainly mechanical strength and electrical/thermal conductivities. Importantly, the structural model of GF should be established from more detailed characterizations and the corresponding properties.