Directed Nanomaterials Assembly for Post-AI Era

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Molecular self-assembly is an intriguing nanofabrication principle widespread in natural living system. My research group have been working on the directed nanoscale assembly of block copolymers (BCPs) and low-dimensional materials, such as carbon nanotubes (CNTs) and graphene over the past two decades. BCP self-assembly can generate dense, periodic nanopatterns with sub-10-nm scale pattern precision, particularly interested in semiconductor nanolithography. We have contributed to this research field from the early days, such as the original works for directed self-assembly (DSA) principle by nanoscale epitaxy (1). Recently, we have reported an interesting IoT application of BCP defective fingerprint nanopatterns for physically unclonable function (PUF) label (2,3) for information security. Low-dimensional carbon materials, including CNTs and graphene, have attracted a great deal of attentions in the era of nanotechnology, whose potential for real-world application can be greatly boosted up by nanoscale assembly into functional architectures. In this regard, our discovery of graphene oxide liquid crystal (GOLC) triggered a big advance in the solution processing of graphene based structures (4), such as 1D graphene fibers, 2D graphene membranes/films, and 3D nanoporous graphene assembly (5). Recently, we demonstrated human muscle like strong artificial muscles composed of graphene based composite structures for the reversible biomimetic movements by light driven remote control (6).

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