Advances in Structural Design of Three-dimensional Nanomaterials

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Nano carbon materials represented by nanotubes (one-dimensional, 1D), graphene (two-dimensional, 2D) and their three-dimensional (3D) architectures are often tagged with keywords, such as high strength, good electrical conductivity, and low thermal resistance, and cannot be observed or achieved in other material systems. They hold great potential for various practical applications and offer possibilities for the development of many never-before-done technologies. Depending on how these nanocarbon materials are constructed, their properties vary as we experienced with graphite and diamond or bulk steel and spring based on the same material element.

While downsizing the concept of structural design to nano-sized carbon materials, these all-carbon structures were conjugated to improve their macro properties so as to meet the requirement of the potential applications. Here, we demonstrated the CNT dry adhesive with the highest adhesion strength (~150N/cm2) against almost all kinds of target surfaces by designing their adhesion surfaces to realize the nano-interlocking adhesion mechanism with rough asperities. Also, we fabricated graphene-based strain sensor with tailor-in-made foam structure which exhibited the real-time monitoring of a wide range of human motions from pulse to the bending of knee joint through the recoverable slippage of neighboring graphene sheets under stretching and releasing. The concept of structural design would be extended to non-carbon nano-materials as exemplified by Boron Nitride tube and sheets. By mimicking the human joint structure, we architected a super-elastic BN sponge possessing the operational temperature up to 1300ºC in oxygen.

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