Nanotube Superfiber Materials: Chapter 14. Direct Dry Spinning of Millimeter-long Carbon Nanotube Arrays for Aligned Sheet and Yarn (Micro and Nano Technologies)

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Ultralong multiwalled carbon nanotube arrays (forests) were grown by chloride-mediated chemical vapor deposition, in which iron chloride was used as a catalyst precursor. Highly spinnable millimeter-long arrays were grown with a very rapid growth rate of 100 μm/min. By stacking long-lasting carbon nanotube (CNT) webs, unidirectionally aligned CNT sheets were fabricated. The sheet was highly anisotropic in electrical and thermal properties and due to high alignment of the CNTs in the sheets. CNT yarns were fabricated using the millimeter-long CNTs and a detailed analysis of various postspin processes, including postspin twisting and multiply twisting, and their effect on CNT yarns were studied. Mechanical properties clearly depended on the dimensions of CNTs, where thinner and longer CNTs led to strong and stiff yarns. Large contacting surface areas in the yarns, brought by closer packing with high-aspect-ratio CNTs, were effective for higher van der Waals interaction leading to higher tensile properties. Growth of millimeter-long highly spinnable CNT arrays and the material properties of tailored large-scale CNT structures, including unidirectionally aligned sheets and spun yarns, are described.

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