Full-Coverage Aligned Semiconducting Enriched Single-Walled Carbon Nanotube Arrays for High-Performance Electronics

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Single-walled carbon nanotube (SWNT) exhibits high carrier mobility, electrostatically favorable ultra-thin body, and exceptional current carrying capacity, therefore, it has been touted for years as a potential silicon replacement in various applications ranging from low-cost thin-film transistors (TFTs) to high-performance logic devices. Despite its remarkable electrical properties, for practical applications, the full advantage of using SWNT can only be realized with aligning electronically pure nanotubes into parallel arrays with fine pitch separation to provide the most transport pathways per unit width and to avoid barriers from tube-tube overlap junctions. Here, we show that well-aligned SWNT arrays with 99% semiconducting nanotube (*s*-SWNT) purity can be assembled with Langmuir-Schaefer (LS) method, which enables full surface coverage with a tube density above 500 tubes/μm. The nanotube pitch is self-limited by the tube diameter plus Van der Waals separation. The intrinsic mobility of the nanotube is preserved after the assembly process. Transistors using this unprecendented high density *s*-SWNT arrays demonstrate exceptional device performance (e.g. drive current density above 120 μA/μm at a drain bias (V_{DS}) of 0.5 V, transconductance (g_m) above 40 μS/μm, along with on/off ratio approaching 10^3). These results set a new benchmark for subsequent devices and circuits using SWNTs.