# Controlled Growth and Modification of Aligned Carbon Nanotubes for Multifunctional Nanocomposites and Nanodevices

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We, along with others, have developed several chemical vapor deposition (CVD) methods for large-scale production of vertically-aligned single-walled, multiwalled, and super-long carbon nanotube arrays.[1-3] The resultant aligned carbon nanotube arrays can be transferred onto various substrates of particular interest in either a patterned or non-patterned fashion. The well-aligned structure provides additional advantages for not only an efficient device construction but also controlled surface modification. The controlled surface functionalization of aligned carbon nanotubes is particularly attractive, as it allows surface characteristics of the aligned carbon nanotubes to be tuned in a region-specific fashion while their alignment structure can be largely retained.[4,5] We have also reported the preferential synthesis of *semiconducting* vertically-aligned single-walled carbon nanotubes for direct use in FETs even without any purification/separation.[6] In collaboration with colleagues in GeorgiaTech (Zhong Lin Wang), University of Akron (Zhenhai Xia), and AFRL (Morley Stone and Michael Durstock), we have further demonstrated that metal-free, nitrogen-doped aligned carbon nanotubes exhibited a high electrocatalytic activity (~4 times of that of the platinum catalyst) for the oxygen reduction reaction (ORR) with an excellent long-term operation stability and free from the crossover/CO-poisoning effect,[7] and that hierarchically-structured aligned carbon nanotube arrays with a straight body segment and a curly entangled top showed almost ten-times stronger shear adhesion force than that of a real gecko foot but still can be easily lifted off in the normal direction when desired.[8] On the other hand, the combination of aligned carbon nanotubes with appropriate macromolecules or other materials (*e.g.*, DNA chains, proteins, metal nanoparticles) has been demonstrated to create synergetic effects, that provide the basis for the development of numerous multifunctional nanocomposite materials and devices,[9,10] including sensors, membranes, flexible electronics, and energy-related systems. In this talk, I will summarize some of our rational concepts for the controlled functionalization of aligned carbon nanotubes for multifunctional materials and device applications, along with an overview on the recent developments in this exciting field.

## References

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