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Oxygen-Assisted Synthesis of Single-Walled Carbon Nanotubes

O. TOLGA GUL, ARITH J. RAJAPAKSE, PHILIP G. COLLINS, University of California, Irvine — Water-assisted chemical vapor deposition (CVD) has become a standard synthesis method for high quality single-walled carbon nanotubes (SWCNTs). Some drawbacks of the water-assisted method, however, include good control of water concentrations in the feedstock and poor control of SWCNT diameters below 2.0 nm. Here, we describe a variation of water-assisted CVD that uses dry feedstocks with a small, controlled quantity of molecular oxygen. Reactions of oxygen with hydrogen in the reaction zone provide all the benefits of water-assisted growth at the substrate while maintaining dry valves and flowmeters. In addition, the oxygen-based technique allows water concentrations in the system to be varied precisely and with short time constants. Perhaps because of the improved control, we find that the SWCNT diameter can be easily tuned by changing the oxygen concentration during the growth phase. Changing the oxygen concentration over the range of 0.5% to 1% varied the resulting SWCNT diameters from 1.5 to 0.5 nm, with typical diameter distributions less than $\pm 30\%$. Control of SWCNT growth within this diameter range is ideal for probing opto-electronic properties of individual SWCNTs and SWCNT devices.

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