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LASER-BASED STUDIES OF CARBON NANOTUBE GROWTH KINETICS

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The mechanisms of carbon nanotube growth have been investigated for both laser vaporization (LV) and chemical vapor deposition (CVD) synthesis techniques through the use of time-resolved, *in situ* laser-based diagnostics. Optimization of both the production of loose single-wall carbon nanotubes (SWNTs) by LV and the sustained growth of mm-long, vertically-aligned arrays of carbon nanotubes (VAA-CNT) by CVD are described. For SWNT growth by laser co-vaporization of carbon and trace metal catalysts at high (1200°C) temperatures, nanotubes are found to grow at ~ 1–5 microns/second to lengths of only several microns, as determined by gated-ICCD imaging and laser spectroscopy of the plume of ejected material. The mechanism of growth termination is uncertain in this case. However, during CVD of nanotube arrays from hydrocarbon gases, sustained growth rates of 0.2 – 0.5 microns/second have been directly measured over *millimeters* of growth at lower (~ 700°C) temperatures. For direct kinetic measurements during CVD, attenuation of a reflected HeNe laser beam and Fabry-Perot fringes are used to measure and control the length of VAA-NT arrays throughout the first 10 microns of growth. For growth of nanotube arrays to millimeters in height, remote microscopy and time-lapse photography are used. The ability to witness the variation of growth rates during a run *from nucleation to termination* permitted the development of a growth model which will be described. Through the application of both the model and the described laser interferometry diagnostics, this provides a realistic, general method to optimize the rapid growth of nanotubes to long lengths for different catalyst/feedstock combinations. Research supported by the U. S. Department of Energy, Division of Materials Science, Basic Energy Sciences.