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IN SITU KINETICS MEASUREMENTS OF CARBON NANOTUBE ARRAY GROWTH DURING CHEMICAL VAPOR DEPOSITION

D. B. Geohegan, A. A. Puretzky*, G. Eres, I. N. Ivanov*, H. Cui, Z. Pan*, H. M. Christen, K. Belay, S. Jesse, A. A. Kinkhabwala and J. Y. Howe

Oak Ridge National Laboratory, Oak Ridge, TN 37831
University of Tennessee, Knoxville, TN 37996
Florida A&M University, Tallahassee, FL 32307

In situ measurements of carbon nanotube growth kinetics have been performed during chemical vapor deposition (CVD) in order to understand the processes limiting rapid growth of nanotubes to long lengths. With optical reflectivity and remote microscopy, the height of vertically-aligned arrays of carbon nanotubes (VAA-NT) can be measured directly *throughout a growth run*, providing growth rates, comparisons of catalyst efficiencies, observation of growth termination and a basis for modeling the relevant processes during CVD nanotube synthesis. In addition, these optical diagnostic techniques permit *in situ* methods to control nanotube lengths or restart growth. 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 arrays to millimeters in height, remote microscopy and time-lapse photography are used. Based upon these measurements, adjustment of the growth parameters (including combinatorial catalysis) is described in order to grow VAA-NT millimeters long at high rates for composite applications. A simple rate equation model is considered to explain the observed growth kinetics and to discuss the main processes responsible for the growth of VAA-NTs. Absolute growth rates determined in these measurements will be compared with those estimated from time-resolved diagnostics of single-wall carbon nanotube growth by laser vaporization. Research supported by the U. S. Department of Energy, Division of Materials Science, Basic Energy Sciences.