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IN SITU DIAGNOSTIC-CONTROLLED CONDENSED PHASE GROWTH OF SINGLE-WALL CARBON NANOTUBES

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\indent Comprehensive imaging and spectroscopy of the plume of material generated by nanosecond laser vaporization (LV) for single wall carbon nanotube (SWNT) synthesis indicated that SWNT grow by the *condensed phase conversion* (CPC) of carbon clusters or nanoparticles by metal catalyst nanoparticles (diameters < 20 nm) during the several seconds typically spent by the plume inside the hot oven. Ex situ annealing of soots prepared by time-restricted growth of SWNT using these diagnostics recently showed that growth could continue at relatively low temperatures ~ 1000 C outside the laser vaporization apparatus, supporting the CPC growth model. These results present opportunities for optimizing CPC growth of SWNT, both inside the LV apparatus and from annealing of nanoparticulate and cluster feedstocks (as recently reported for C$_{60}$/Ni by Schlittler et al, *Science* {\bf 292}, 1136 (2001)).\\

\indent To investigate the effect of nanoparticle density on SWNT yield and growth rates during the annealing period, the pulse width of the vaporization laser was drastically changed to ~ 150 microseconds (~ 80, 200ns-pulses, free running mode of Nd:YAG laser) to evaporate the composite C/Ni/Co target. This modification results in a natural confinement, providing a tenfold increase in density over the short-pulse synthesis approach. Growth rates (estimated through in situ imaging) and material characterizations (from ex situ TEM, TGA, FESEM, Raman spectroscopy) will be presented. Material collected after incomplete conversion will be tested for continued CPC growth.\\

\indent Ex situ annealing experiments will also be described using different cluster and nanoparticulate feedstocks to investigate the growth of SWNT by CPC. Rapid thermal annealing is accomplished by CO$_{2}$ laser irradiation with in situ pyrometry utilized to estimate the sample temperature.\\

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