SWNT Alignment: Methods, Characterization and Properties

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SWNT's can be aligned after growth by uniaxial shear flow, magnetic field, or fiber extrusion into a coagulation bath. The resulting preferred orientation should produce anisotropy in electrical and thermal conductivity, modulus, strength etc. In particular, properties measured parallel to the alignment direction should be enhanced relative to unoriented material. We characterize texture using both x-ray diffraction and polarization-dependent Raman scattering in order to separate the alignment of crystalline ropes from that of the ensemble. Data is analyzed using a "two-phase" model with parameters A representing a completely random fraction (e.g. tangled tubes or ropes) and a Gaussian full width at half-maximum FWHM for the the (1-A) fraction of oriented tubes/ropes. The best alignment (small A and FWHM) is obtained for melt-spun polymer fibers containing 1-8 wt.fields are less well aligned; here the correlation among field strength, A and FWHM using both techniques provides information about the alignment mechanism. Fiber extrusion produces the poorest alignment, which can be improved by stretching in the gel state. Some physical properties will be presented and correlated with sample texture. This work was done in collaboration with Rice University, CRPP/CNRS Bordeaux and AlliedSignal Corp.