Controlling the casting parameters for fabricating highly oriented carbon nanotube/polymer composite films using a robotic dispenser

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Carbon nanotubes (CNTs), due to their exceptional chemical structure and uni-dimensionality, have gained huge scientific interest for fabricating lightweight, portable, and flexible electronics by exploiting their mechanical, electrical, and thermal properties [1, 2]. The theoretical and simulation-based studies on CNTs revealed significantly high phonon-dominated thermal conductivity, in the range of thousands of $W.m^{-1}.K^{-1}$ [3], which triggered a major research endeavor in this area. However, no CNT/polymer composite has yet shown such comparable performance which is mainly attributed to the loose and isotropic CNT network in the films. Therefore, development of facile orientation techniques is highly required for utilizing the inherent anisotropic properties of single CNTs in the films.

A new technique for casting long ribbon-shaped CNT/polymer composite films with aligned CNTs has been recently developed by our group [4]. In this method, a programmable robotic dispenser was utilized for drawing the films. It is hypothesized that, when the dispersion of CNT/polymer composite flows through the narrow needle, the shear stress at its inner wall leads to the alignment of CNTs parallel to the flow direction. In this work, the role of several casting parameters in orientation was studied by fabricating the films under varying conditions and comparing the corresponding polarized-Raman spectra. It was found that surface energy of the substrate, CNT/polymer concentration in the dispersion, needle diameter, robotic speed, dispensing speed, etc. significantly affects the degree of orientation. Attaining optimum CNT alignment in the films by controlling these parameters where the streamlined orientation is preserved, will be discussed during the presentation.

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