Effect of Single-Walled Carbon Nanotubes on the Increase of Thermal Expansion Coefficient of Nanotube-Colloidal Polymer Composite Films

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Polymer thermal expansion has been widely used in thermal actuator applications for several years [1]. It has been found that when the thermal expansion of a polymer is restricted in two directions by rigid fillers, the expansion in the third direction is increased. This effect is called "squeezing" [2]. The linear coefficient of thermal expansion (CTE) of single-walled carbon nanotubes (SWNTs) (10^{-6} K^{-1}) [3] is markedly lower than the volume CTE of an acrylic polymer (10^{-4} K^{-1}) [4]. Thus, in a composite situation, such squeezing effects should be more apparent due to the thermal strain mismatch between the matrix and the filler. Here, we show an unusual example of such squeezing behaviour in ultra-thin composites prepared using latex processing. During film formation, the nanotubes are forced into interstitial sites forming belt-like, constraining networks around the individual particles during film coalescence. This results in extremely high linear CTE in the direction perpendicular to the film. Possible applications are discussed.

References:

[1] M.C. LeMieux, M.E. McConney, Y.H. Lin, S. Singamaneni, H. Jiang, T.J. Bunning and V.V. Tsukruk; *Nano Letters*, 2006, ***6****(4)*, 730-734. [2] J.C. Halpin; *Technomic Publishing*, Lancaster, PA, 1992, *2nd ed.*, 180-181.[3] H. Jiang, B. Liu and Y. Huang; *Journal of Engineering Materials and Technology-Transactions of the Asme*, 2004, ***126****(3)*, 265-270. [4] J. Brandrup, E.H. Immergut, E.A. Grulke, A. Abe and D.R. Bloch; *John Wiley & Sons*, New York, 1999, *4th ed.*, V/87.