Raman Scattering from Single WS_2 Nanotubes Embedded Within Stretched PVDF Electrospun Fibers

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Supporting Information

Fig. S1 shows the designed computer- controlled "Tensile system" load-cell setup (a modification of the setup used in Ref. 1 and references therein). The system is constructed from a LTA-HL "Newport" step motor (up to 25 mm in a step resolution of 0.01 mm) and a type 9207 "Kistler" load cell (from 1-50 N), with its output being amplified (type 5015 "Kistler" amplifier), which enables the load sensitivity of ~10^{-3} N. A dedicated software enables the concomitant monitoring of the Raman scattering and the load during the fibers stretching while taking into account the relaxation of the fibers under stretched "static" conditions. A set of loads/stretch scheme with the respective Raman response at the various stages was acquired as an output of the experiment.

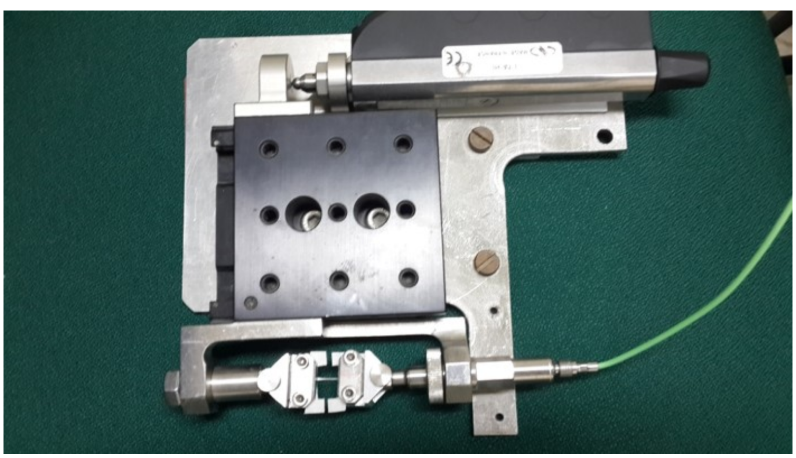

Figure S1. The Raman-Tensile system stretching apparatus. The step motor (top) pushes the bench against a stationary load cell.

The relative Young's modulus (E/E_0) is defined as the effective Young's modulus of a composite fiber (E) normalized by the modulus of the polymer matrix (E_0). **Figure S2** shows the relative Young's modulus of INT for simulated nanocomposites for "strong" adhesion (k_{np} = 5 k_{pp}) and "weak" interaction (k_{np} = 0.05 k_{pp}).

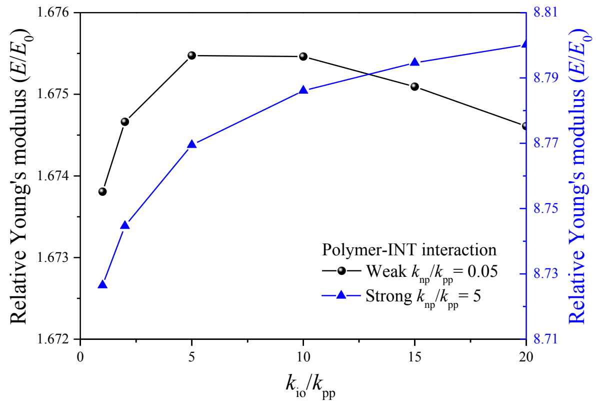

Figure S2. Relative Young's modulus of INT for simulated nanocomposites, the relative Young's modulus (E/E_0) is defined as the effective Young's modulus of a composite fiber (E) normalized by the modulus of the polymer matrix (E_0).

Notably, the interaction between different layers of INT (k_{io}) has a slight effect on the Young's modulus of INT-polymer nanocomposites. To study the effect of this interaction (k_{io}) on the deformation of INT, we measured the elongations of the outer layer and the inner layer separately (**Figure S3**). The "strong" adhesion (k_{np} = 5 k_{pp}) leads to a significant elongation of INT, with the elongation ratio (strain) around 10 times that of system with "weak" interaction (k_{np} = 0.05 k_{pp}). This could be only explained by enhanced stretching of INT with "strong" polymer – INT interaction

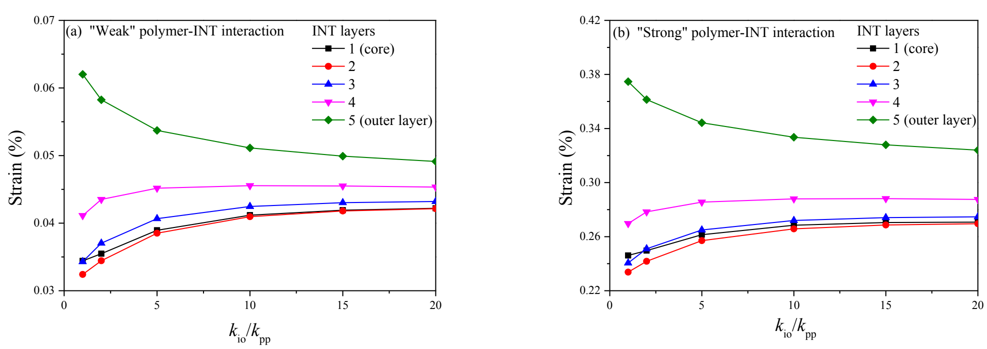

Figure S3. Strain of INT for simulated nanocomposites with "weak" polymer – INT interaction system (a), and "strong" polymer – INT interaction system (b). The strain is defined as the elongation of INT ($\Delta l_{INT} = l - l_{INT}$) divided by the original length INT (l_{INT}).

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1. Q. Zhao and H. D. Wagner, Raman spectroscopy of carbon-nanotube-based composites, *Phil. Trans. R. Soc. Lond.* A 362, 2407 (2004).