

## Supporting information

# Correlating Synergistic Reinforcement with Chain Motion in Elastomer/Nanocarbon Hybrids Composites

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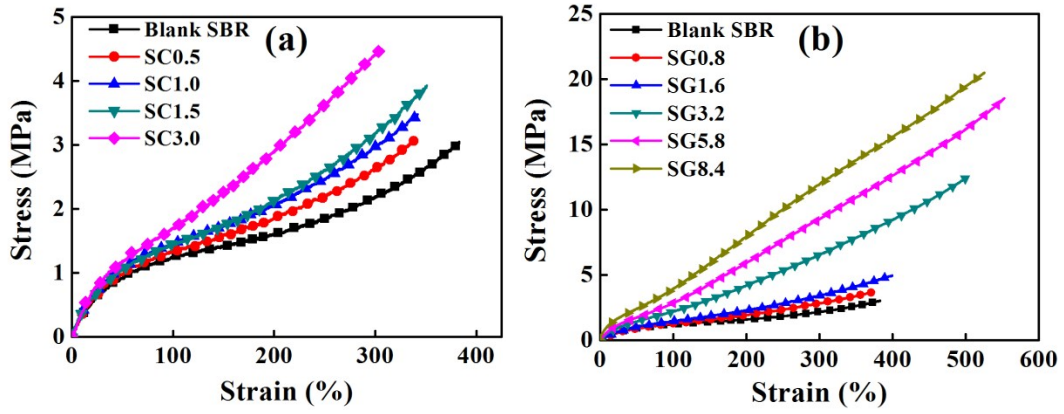


Figure S1. Typical stress-strain curves of SBR/CNTs (a) and SBR/rGO (b) composites

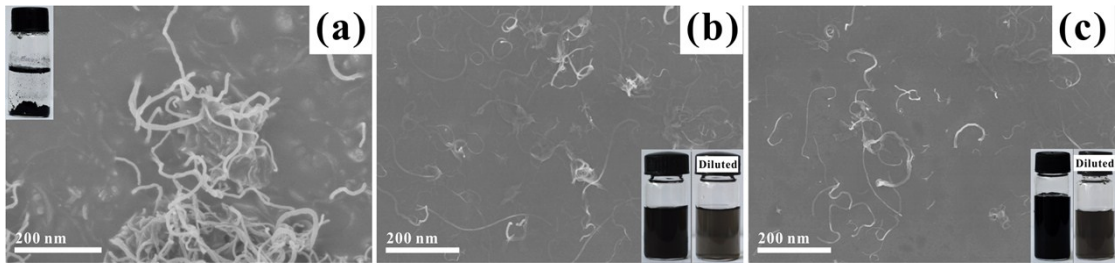


Figure S2. SEM images of pristine CNTs (a) and rGO-CNTs hybrid suspensions with different rGO/CNTs ratios at (b) 3:1 and (c) 2:1.

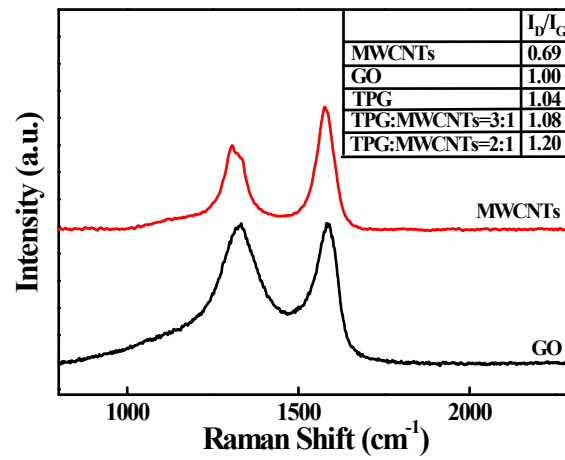


Figure S3. Raman spectra of GO and MWCNTs

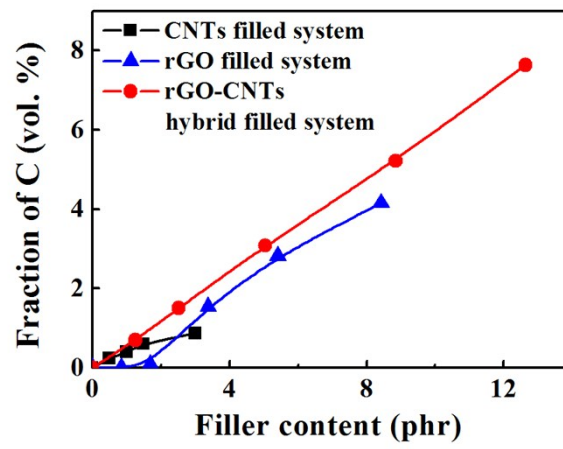


Figure S4. The computed  $C$  values of SBR composites with different fillers as a function of filler content.

Table S1. Experimental values of mechanical properties for SBR composites with different filler.

	TS <sup>a</sup>	TE <sup>b</sup>	T <sup>c</sup>	Synergy (%)			EB <sup>d</sup>
				TS	TE	T	
Pure SBR	3.2	8.6	6.3				392
SG3	12.2	21.4	29.9				568
SC0.5	3.0	7.8	5.8				329
SG3C0.5	15.4	23.0	34.9	95.9	57.8	95.3	580
SC1	3.4	8.6	6.6				330
SG3C1	18.5	23.2	48.0	130.5	55.2	163.1	644
SC1.5	3.94	10.4	7.1				341
SG3C1.5	20.0	27.7	52.7	140.2	74.1	184.3	632
SC3	4.5	12.2	7.2				321
SG3C3	20.2	28.0	49.1	134.86	67.1	164.2	603

<sup>a</sup>TS: Tensile strength, MPa. <sup>b</sup>TE: Tear Strength, kN/m. <sup>c</sup>T: Toughness, MJ/m<sup>3</sup>.

<sup>d</sup>EB: Elongation at Break, %.

Table S2. Experimental values of mechanical properties for rGO-CNTs hybrid filled SBR composites at a rGO-CNTs weight ratio of 2:1.

	TS <sup>a</sup>	TE <sup>b</sup>	T <sup>c</sup>	EB <sup>d</sup>
SG0.8C0.4	3.9	14.2	8.1	375
SG1.6C0.8	10.9	22.6	24.4	557
SG3.2C1.6	20.7	29.7	50.9	600
SG5.8C2.9	24.0	30.3	64.9	572
SG8.4C4.2	26.0	37.2	64.3	496

<sup>a</sup>TS: Tensile strength, MPa. <sup>b</sup>TE: Tear Strength, kN/m. <sup>c</sup>T: Toughness, MJ/m<sup>3</sup>. <sup>d</sup>EB: Elongation at Break, %.

Table S3. Experimental values of  $E'$  at rubbery state,  $\tan \delta$  peak, energy loss fraction  $W$  and volume fraction of confining region  $C$  for SBR composites with different fillers.

	$E'$ at 30 °C	Tan $\delta$ peak value	$W$	$C$ (%)
Blank SBR	2.49	1.715	0.844	0
SC0.5	2.79	1.693	0.842	0.231
SC1	2.90	1.675	0.840	0.398
SC1.5	2.99	1.655	0.839	0.585
SC3	3.85	1.626	0.836	0.868
SG0.8	3.19	1.717	0.844	0.065
SG1.6	3.45	1.708	0.843	0.087
SG3	5.74	1.571	0.832	1.191
SG5.8	9.04	1.448	0.812	2.822
SG8.4	12.44	1.345	0.810	4.153
SG0.8C0.4	3.23	1.644	0.838	0.694
SG1.6C0.8	3.66	1.565	0.831	1.504
SG3C1.5	6.04	1.436	0.818	2.973
SG5.8C2.9	9.60	1.270	0.800	5.222
SG8.4C4.2	13.53	1.124	0.779	7.635

Table S4. Freezing-point depression of swollen SBR composites with different fillers.

	$\Delta T$ (°C)
Blank SBR	-
SC1.5	1.3
SG3	3.2
SG3C1.5	6.3
SG0.8C0.4	1.1
SG8.4C4.2	9.8