Supplementary

Silicone Composites with CNT/Graphene Hybrid Fillers: A Review

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To assess the synergistic improvement in the parameters of CNT/G/PDMS composites, their values were compared with the theoretical ones (α(t)) calculated from the additive model:

$$a(t) = \varphi_{CNT} \times a(CNT/PDMS) + \varphi_G \times a(G/PDMS) \tag{1}$$

wherein φ_{CNT} is the fraction of CNTs in hybrid filler; φ_G is the fraction of graphene in hybrid filler; $\alpha_{CNT/PDMS}$ is an experimental value of the target parameter for CNT/PDMS composites at $X\%$ filler loading; $\alpha_{G/PDMS}$ is an experimental value of the target parameter for G/PDMS composites at $X\%$ filler loading.

The total relative improvement was then found as

$$\delta = \frac{a(exp) - a(t)}{a(t)} \times 100\% \tag{2}$$

wherein α(exp) is an experimental value of the target parameter for CNT/G/PDMS composites at $X\%$ filler loading.

In this way, we calculated the synergistic improvement of tensile strength (σ_{ts}), elongation at break (ε), electrical conductivity (σ_e), electric heating performance (h_{rc}), thermal conductivity (λ) using data from

Pradhan et al. [1]:

$$
\begin{aligned}
&\delta(\sigma_{ts}) \\
&= \frac{\sigma_{ts}(exp) - (\varphi_{CNT} \times \sigma_{ts}(CNT/PDMS) + \varphi_G \times \sigma_{ts}(G/PDMS))}{\varphi_{CNT} \times \sigma_{ts}(CNT/PDMS) + \varphi_G \times \sigma_{ts}(G/PDMS)} \\
&\times 100\%
\end{aligned} \tag{3}
$$

$$\delta(\sigma_{ts}) = \frac{0.67 - (0.5 \times 0.44 + 0.5 \times 0.37)}{0.5 \times 0.44 + 0.5 \times 0.37} \times 100\% \approx 65\% \tag{4}$$

$$
\begin{aligned}
\delta(\varepsilon) &= \frac{\varepsilon(exp) - (\varphi_{CNT} \times \varepsilon(CNT/PDMS) + \varphi_G \times \varepsilon(G/PDMS))}{\varphi_{CNT} \times \varepsilon(CNT/PDMS) + \varphi_G \times \varepsilon(G/PDMS)} \\
&\times 100\%
\end{aligned} \tag{5}
$$

$$\delta(\varepsilon) = \frac{194 - (0.5 \times 104 + 0.5 \times 90)}{0.5 \times 104 + 0.5 \times 90} \times 100\% = 100\% \tag{6}$$

Yan et al. [2]:

$$\delta(\sigma_e) = \frac{\sigma_e(exp) - (\varphi_{CNT} \times \sigma_e(CNT/PDMS) + \varphi_G \times \sigma_e(G/PDMS))}{\varphi_{CNT} \times \sigma_e(CNT/PDMS) + \varphi_G \times \sigma_e(G/PDMS)} \times 100\% \tag{7}$$

$$\delta(\sigma_e) = \frac{1.37 - (0.9 \times 0.435 + 0.1 \times 0.161)}{0.9 \times 0.435 + 0.1 \times 0.161} \times 100\% \approx 236\% \tag{8}$$

$$\delta(h_{rc}) = \frac{h_{rc}(exp) - (\varphi_{CNT} \times h_{rc}(CNT/PDMS) + \varphi_G \times h_{rc}(G/PDMS))}{\varphi_{CNT} \times h_{rc}(CNT/PDMS) + \varphi_G \times h_{rc}(G/PDMS)} \times 100\% \tag{9}$$

$$\delta(h_{rc}) = \frac{7.46 - (0.9 \times 5.79 + 0.1 \times 6.89)}{0.9 \times 5.79 + 0.1 \times 6.89} \times 100\% \approx 26\% \tag{10}$$

Chen et al. [3]:

$$\delta(\sigma_e) = \frac{\sigma_e(exp) - (\varphi_{CNT} \times \sigma_e(CNT/PDMS) + \varphi_G \times \sigma_e(G/PDMS))}{\varphi_{CNT} \times \sigma_e(CNT/PDMS) + \varphi_G \times \sigma_e(G/PDMS)} \times 100\% \tag{11}$$

$$\delta(\sigma_e) = \frac{27 - (0.5 \times 0.07 + 0.5 \times 14)}{0.5 \times 0.07 + 0.5 \times 14} \times 100\% \approx 284\% \tag{12}$$

Sun et al. [4]:

$$\delta(\sigma_e) = \frac{\sigma_e(exp\ (4.7\%)) - (\sigma_e(CNT(2\%)/PDMS) + \sigma_e(G(2.7\%)/PDMS))}{\sigma_e(CNT(2\%)/PDMS) + \sigma_e(G(2.7\%)/PDMS)} \times 100\% \tag{13}$$

$$\delta(\sigma_e) = \frac{3150 - (73 + 674)}{73 + 674} \times 100\% \approx 322\% \tag{14}$$

References

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