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Simultaneously facilitating dispersion and thermal reduction of graphene oxide to enhance thermal conductivity of poly(vinylidene fluoride)/graphene nanocomposites by water in continuous extrusion

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ABSTRACT

Poly(vinylidene fluoride)/graphene oxide (PVDF/GO) nanocomposites were fabricated by a melt mixing extrusion especially with water injection. It was found for the first time that the injected water simultaneously facilitated the dispersion and in situ thermal reduction of the unfunctionalized GO in the PVDF matrix under environmental friendly conditions in melt extrusion. The injected water accelerates the removal of oxygen-containing groups especially C−O group and the transformation of carbon sp^3 into sp^2 bonds of the GO through enhancing the interaction between the PVDF and GO and facilitating the hydrothermal dehydration of GO. The interfacial interaction between the GO and PVDF facilitated the nucleation of crystallites at the PVDF-GO interfaces, which can reduce the interfacial thermal resistivity. Thus, the thermal conductivity of the PVDF/GO nanocomposites prepared with water injection was significantly improved. Compared with the neat PVDF sample, the enhancements in the thermal conductivities were 64.1% and 132.5% for the nanocomposites with low loading of 1.0 wt% prepared without and with water injection, respectively. The results provide a scalable and environmentally benign approach for fabricating thermally conductive nanocomposites without complex dispersion and reduction processes.

Keywords: Green processing; Polymer-matrix composites; Graphene; In situ thermal reduction; Interface/interphase; Thermal conductivity

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