Electronic Supplementary Material (ESI) for RSC Advances.

SUPPORTING INFORMATION

Enhanced positive temperature coefficient behavior of the high-density polyethylene composites with multi-dimensional carbon fillers and their use for temperature-sensing resistors

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S1. Schematic diagram of modification of CB nanoparticles

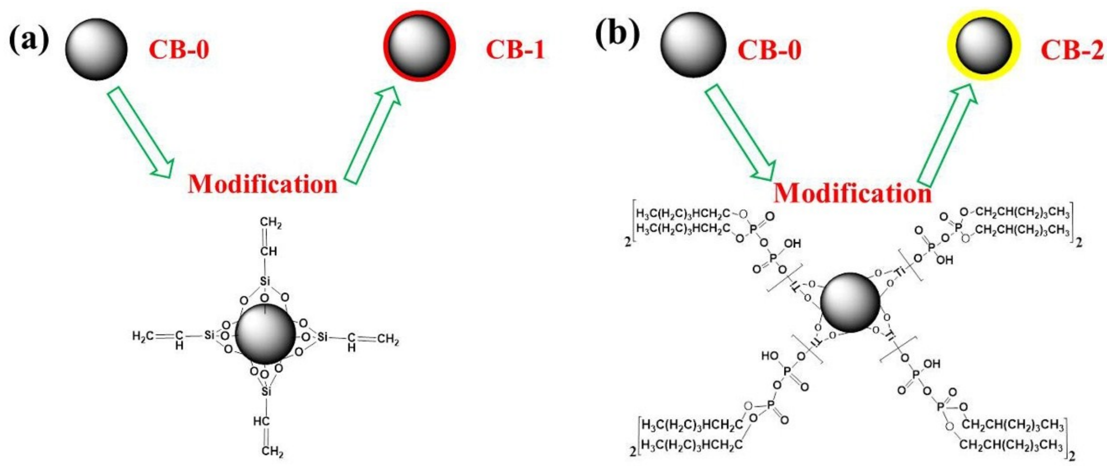

Fig. S1. Schematic diagram of modified CB by the coupling agents (a) A171 and (b) NDZ-311, respectively.

Fig. S1 shows the reaction between the CB nanoparticles and coupling agents with different molecular structure. The layer on the surface of CB can improve the interfacial action between CB and HDPE.

S2. PTC behavior of the CB-0/HDPE nanocomposites

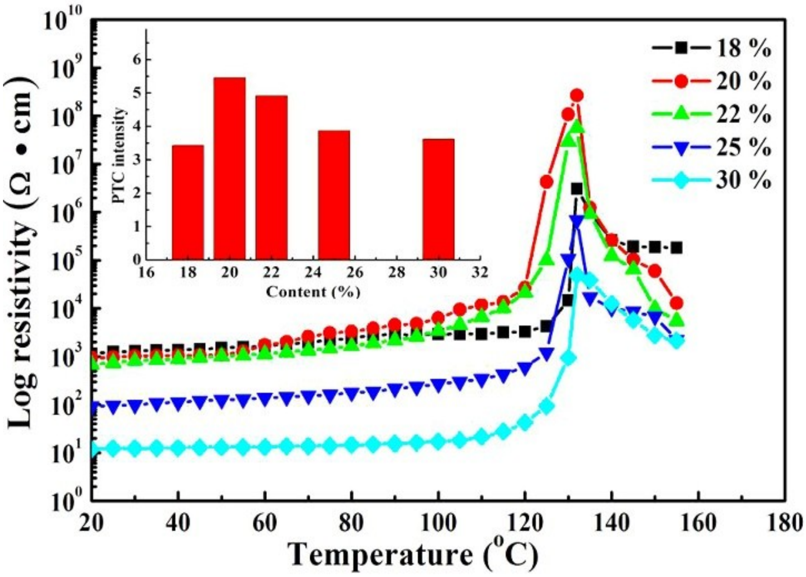

Fig. S2. Resistivity-temperature behavior of the CB-0/HDPE nanocomposites with different fractions of CB-0. Inset is PTC intensity of the composites calculated according to Eq. (1).

Fig. S2 shows temperature dependence of the resistivity of HDPE nanocomposites with different contents of CB-0. It can be seen that the resistivity of CB-0/HDPE nanocomposites sharply increases above a specific temperature. When the mass fraction of CB-0 is up to 20 wt%, the PTC intensity is 5.45 at 132 ^{o}C as shown in the inset of Fig. S2. It indicates that the HDPE nanocomposites show a good PTC effect near the percolation threshold.

S3. Percolation thresholds of the CB-0/HDPE nanocomposites

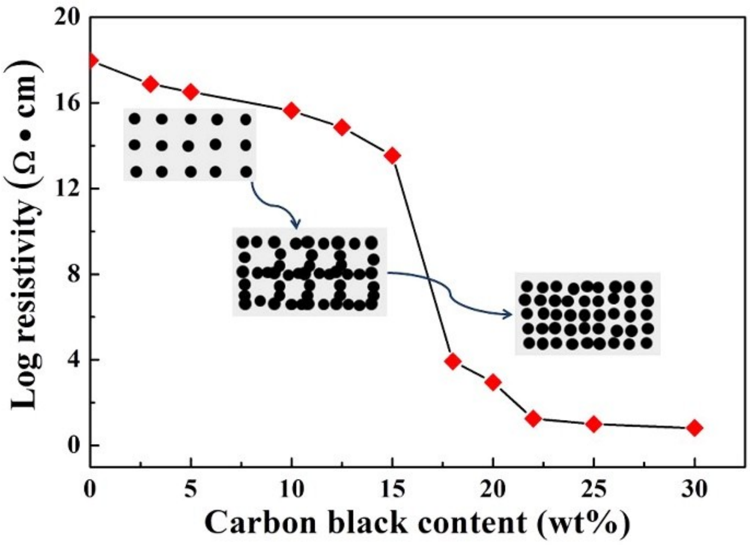

Fig. S3. Relationship between the filler content and volume resistivity of the CB-0/HDPE nanocomposites at room temperature.

Fig. S3 displays the log volume resistivity of the CB-0/HDPE nanocomposites as a function of CB-0 content at room temperature. There is a rapid decrease in the log resistivity of the HDPE nanocomposites with increasing CB-0 content. With the increase of CB-0 content, the CB-0 nanoparticles gradually contact with each other, resulting in an insulator-to-conductor transition. This rapid decrease is attributed to the formation of conductive paths. The sharp break indicates the aggregation of conductive nanoparticles to form network, which is defined as the percolation transition, and the critical weight or volume fraction of the filler is the threshold value that divides the composite into either an insulator or conductor. Under this experimental condition, the percolation transition threshold for the HDPE nanocomposites was approximately 20 wt% CB-0.