Electronic Supplementary Material (ESI) for RSC Advances.

CNT-grafted glass fibers as a smart tool for the epoxy cure monitoring, UV-sensing and thermal energy harvesting in model composites

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Supporting Information

Figure S1. (a) Apparent interfacial shear strength (τ_{app}), and (b, c, d) SEM fracture surface morphologies of bare GF, GF-APS, and GF-CNT, respectively.

Figure S2. SEM image of the FIB interphase-section at an intermediate step of the milling-polishing process.

Figure S3. Schematic illustration of the set-up used for the electrical measurements of (a) single GF-CNT and (b) GF-CNT/epoxy composites.

Figure S4. SEM image (optical image as an inset) of the MWCNT 'bucky paper' film used for electrical conductivity measurements.

S1. *Single fiber pull-out tests / Interfacial adhesion properties*

In an attempt to study the interfacial adhesion strength, single fiber pull-out tests (SFPOT) were performed on single fiber model micro-composites. Bare GFs as-received from the spinning process (without a sizing content) have been compared with gamma-aminopropyltriethoxysilane (γ-APS) modified GFs (GF-APS); widely used as a coupling agent to improve the adhesion strength of GF/epoxy composites, and with GFs grafted with MWCNTs (GF-CNT). GF-CNT exposed the highest interfacial adhesion strength (65.4±6.4 MPa) with an increase of ~48% compared to the GF-APS, and ~95% compared to bare GFs, as reported in our previous work [3].

S2. *Preparation of single fiber composite interphase section by Focused Ion Beam (FIB)*

In order to investigate the interphase microstructure of GF-CNT/epoxy composite, a focused ion beam process (FIB) was employed to prepare a composite interphase section. Details about the FIB process could be found elsewhere [3].

S3. *Experimental set-up for the fiber resistance measurements*

The DC (direct current) electrical resistance (R) of individual GF-CNT filaments, and the respective epoxy composite with specific dimensions, was measured with the two different set-ups schematically shown in Fig. S3.

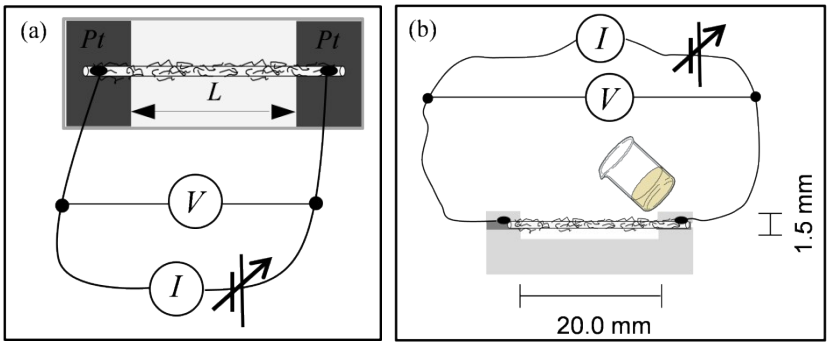

Fig. S3 - Schematic illustration of each set-up used for the electrical measurements of (a) single GF-CNT and (b) GF-CNT/epoxy composite.

S4. *Electrical properties of MWCNTs used for the GF-CNT*

The inherent electrical properties of acid treated MWCNTs used for coating the GF-yarns were measured with a four-probe method. The measurements were performed on a bulk MWCNT film which is given as an inset in Fig. S4 (Fig. S4 shows the SEM image of the MWCNT bucky paper film). The MWCNT film was prepared by filtering an aqueous suspension of 100 mg MWCNT-COOH (0.125 mg/ml) through a polycarbonate membrane (0.4 μm pore size) and after drying, the film was thoroughly peeled off from the membrane and the thickness was measured to be ~100 μm. By cutting the bucky paper in small rectangular pieces, the resistance of at least 20 pieces was measured, and after calculations following the expression: $\sigma_{CNT\text{-}film} = L / (R \times s)$, the mean conductivity value was in the range of 2.3×10^3 S/m.

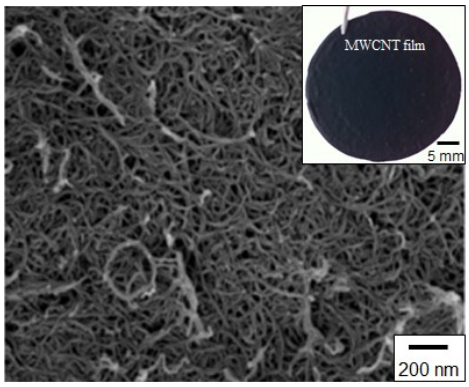

Fig. S4 - SEM and optical (inset) image of the MWCNT 'bucky paper' film used for the electrical conductivity measurements.

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[3] L. Tzounis, M. Kirsten, F. Simon, E. Mäder, M. Stamm, Carbon 2014, 73, 310.