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# Turning Carbon Fiber into a stress-sensitive composite material

M. Villani, D. Delmonte, M. Culiolo, D. Calestani, N. Coppedè, M. Solzi, L. Marchini, R. Bercella, A. Zappettini

## Electronic Supplementary information

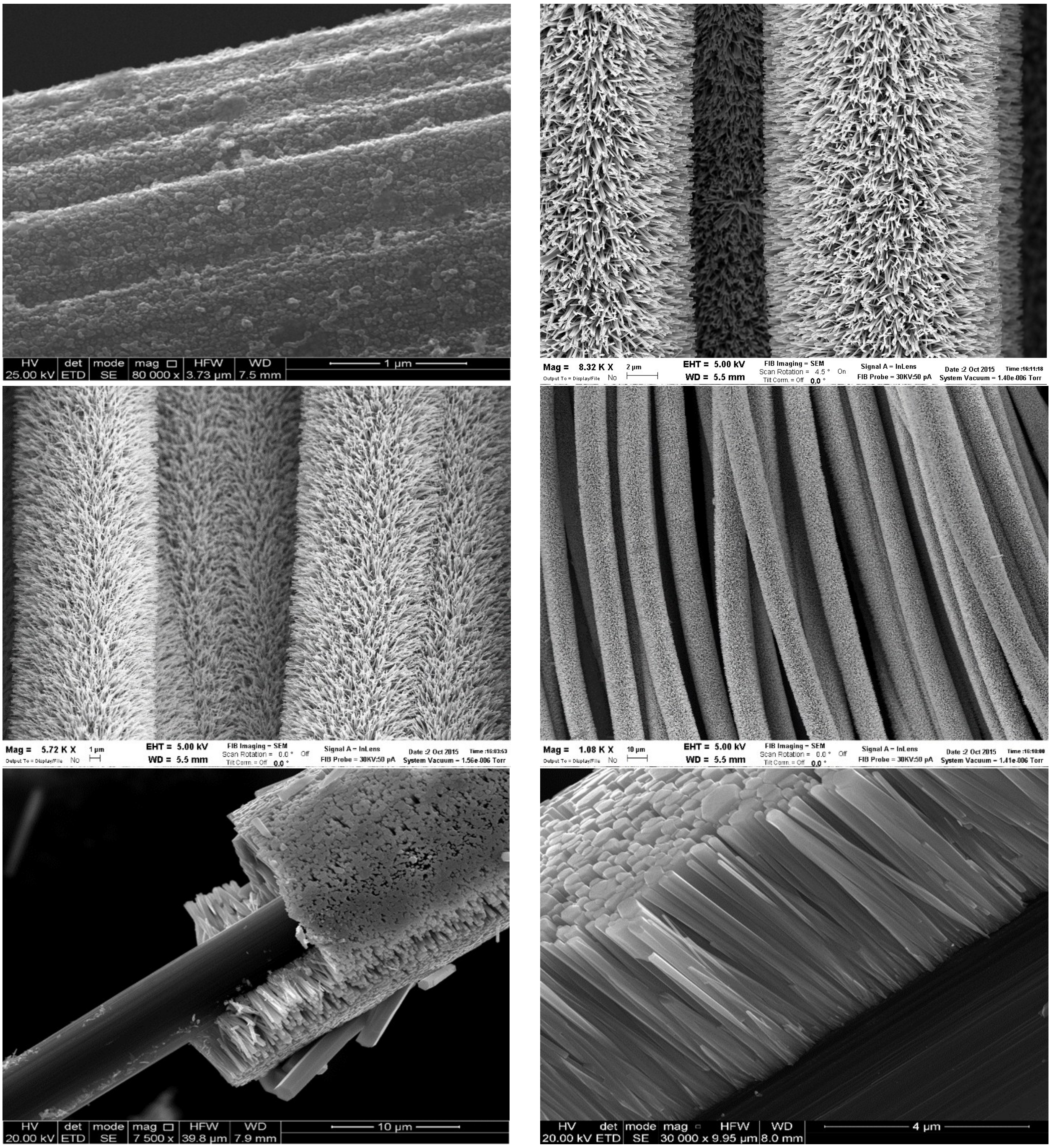



**Figure S1**: FE-SEM images of uniformly distributed seed layer deposited with SILAR technique (a); ZnO nanorods grown at different temperature / precursor concentration (b-f). Refer to methods section for further details.

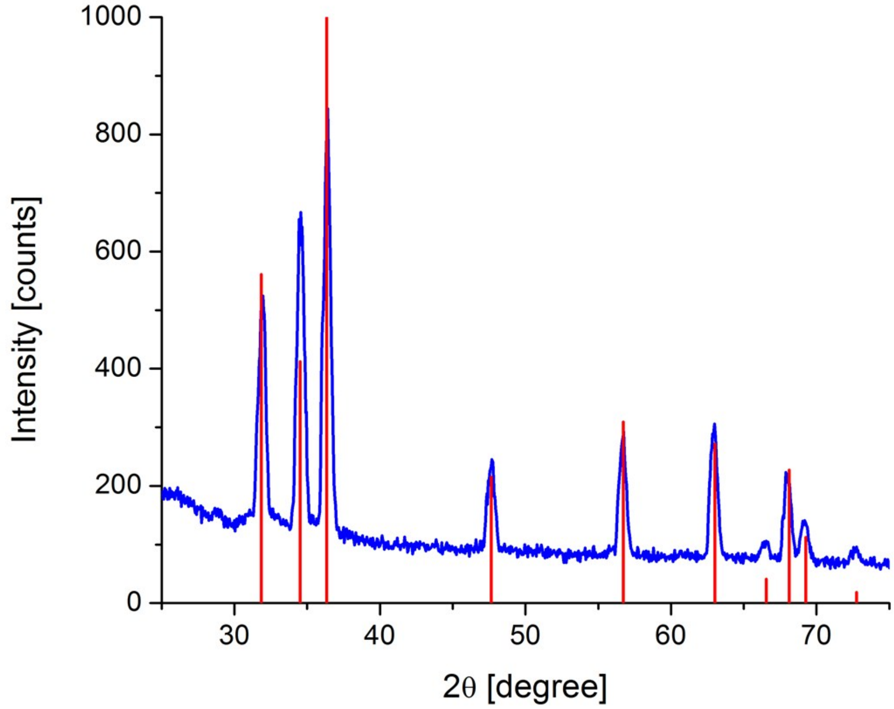



**Figure S2**: XRD pattern of as grown ZNR on CF is reported (blue), all peaks have been indexed as hexagonal ZnO (s.g. P63mc) according to JCPDS no. 79-0205 (red). Characterization is performed with a Thermo ARL X'tra diffractometer (Cu K$\alpha$ source, $\Theta$–$\Theta$ Bragg-Brentano geometry, $10^{-4}$ degree accuracy).

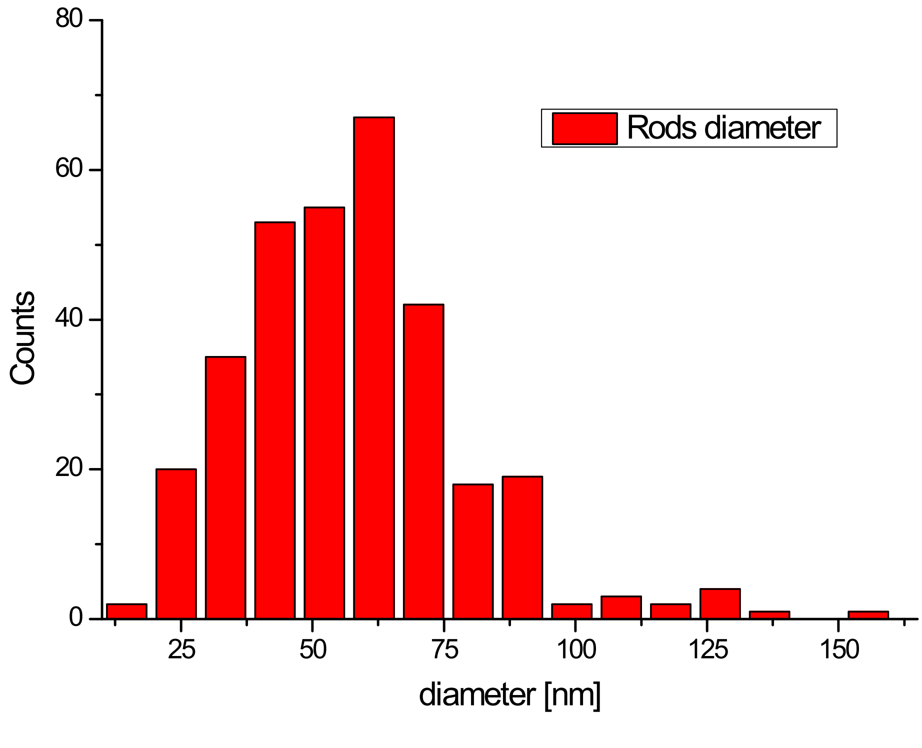



**Figure S3**: Statistics on ZnO NR diameter distribution.

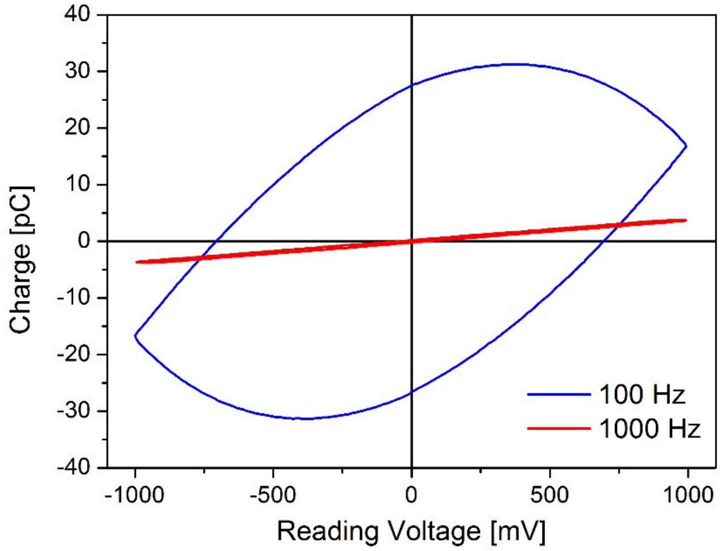



**Figure S4**: Charge/Voltage characteristic measured using triangle pulses at different frequencies: at low frequency (100 Hz, red line) the device shows a resistive behavior; increasing the frequency (1 KHz, blue line) a dielectric response is observed.

The device is characterized by two comparable electric contributions superimposed at least in the low frequency bias regime. Basically, its relative equivalent circuit can be depicted as a planar capacitor in parallel with a shunt resistance.

By means of an external bias the current may flows both in the dielectric and resistive branch of the circuit depending on the ratio between the circuit elements impedance. The quicker way to understand which of these two signals are predominant goes through a monitoring of the current intensity vs Voltage curve, being the two response characterized by a different voltage-dependence. Namely:

$$I = \frac{1}{R}V$$

$$I = \frac{dQ}{dt} = C\,\frac{dV}{dt}$$

which corresponds to a quadratic (resistive) and linear (dielectric) dependence as a function of the applied voltage respectively:

$$Q = \frac{1}{2R}V^2$$

$$Q = CV$$

In the proposed characterization, the Dynamic Hysteresis Loop (DHM) measurement has been performed using triangle pulses at different frequencies, in order to investigate the origin of the current flow, which is the superimposition of a quadratic and a linear term. By performing a low-frequency characterization (100 Hz), the red curve reported in Figure S2 depicts a resistive behavior (quadratic trend). By varying the frequency of the triangle pulse up to 1 kHz, the linear trend between charge and voltage emerges as reported in Figure S2, blue curve. Dielectric characterization has been performed under the latter conditions.

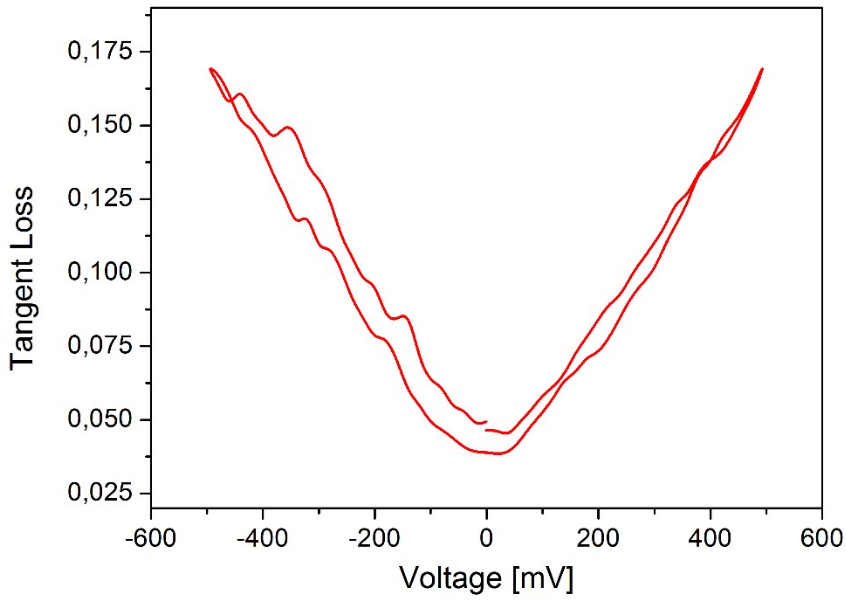
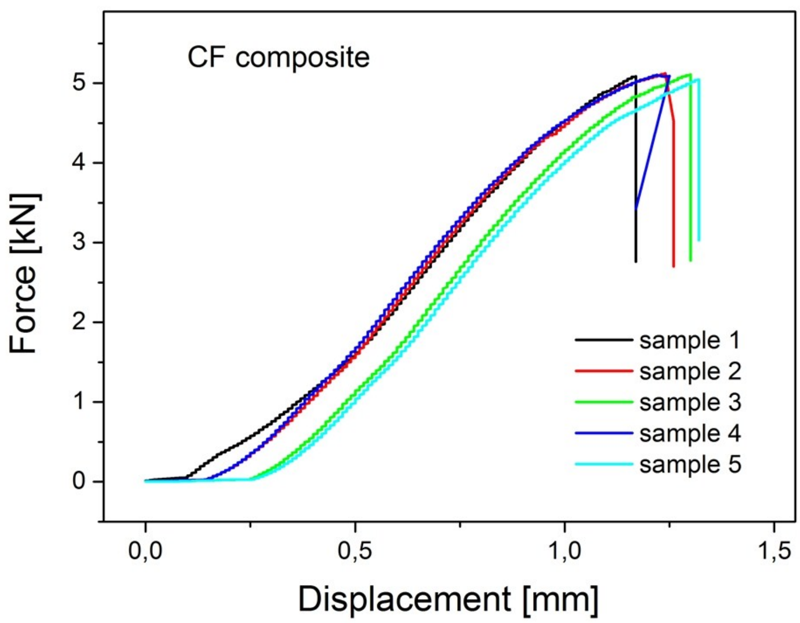



**Figure S5**: Tan(δ) loss measured during the capacitance versus voltage measurement reported in Figure 3. The typical leakage-like trend is observed with little variation from the dielectric/capacitive regime.



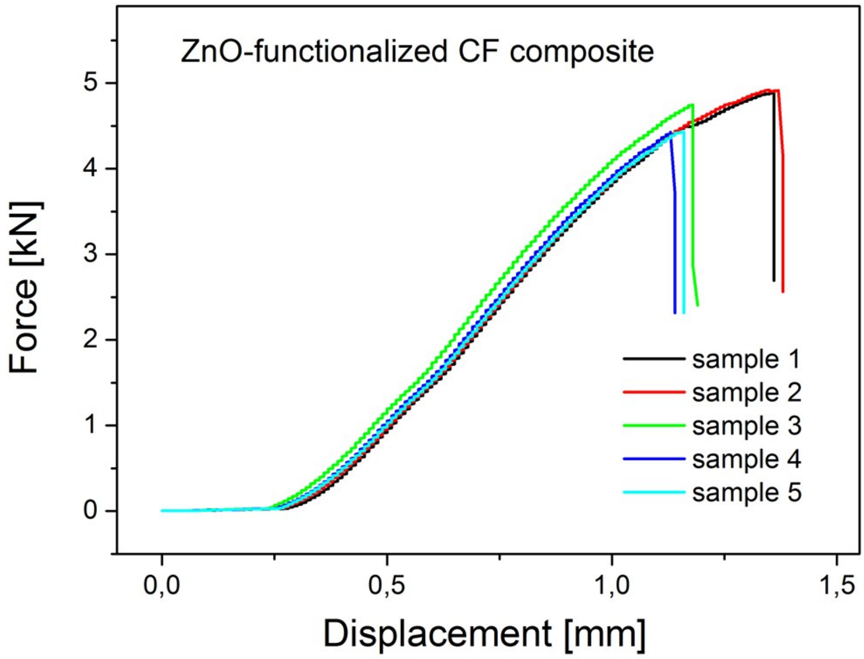



**Figure S6**: ILSS measurement performed on pristine CF composite material (top) and ZNR-functionalized CF-based composite material (bottom). For further details, please refer to the experimental section (paragraph 2.5) of the manuscript.