

Electrically conductive polymer/CNT composites with application potential for sensor technology

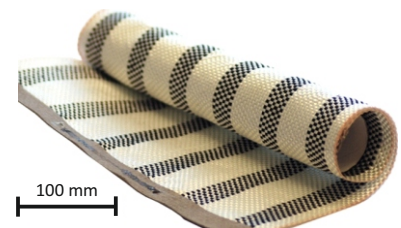
Electrically conductive polymer composites (CPCs) are multifunctional materials and can be used for the detection of environmental influences due to their sensory properties.

The use of electrically conductive carbon nanotubes (CNTs) and other conductive carbon nanoparticles (CNPs) is particularly suitable.

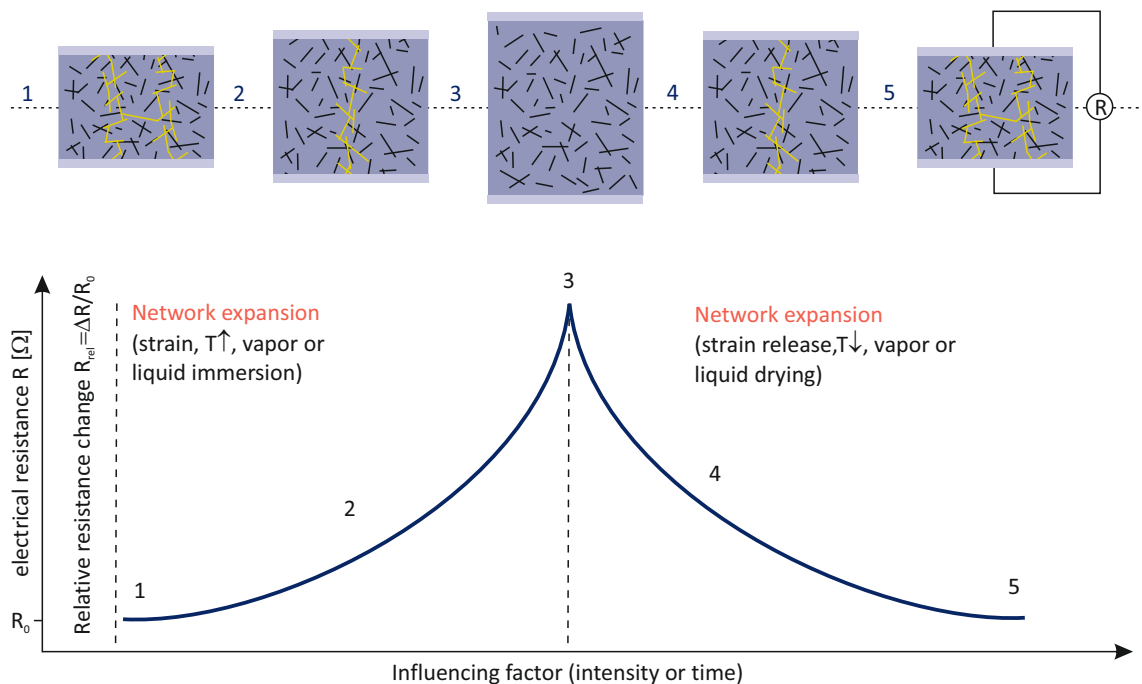
Due to interactions of the CPCs with the environment, changes can occur in the structure of the conductive filler networks which lead to changes in the electrical resistance ΔR of the CPC.

This allows to detect:

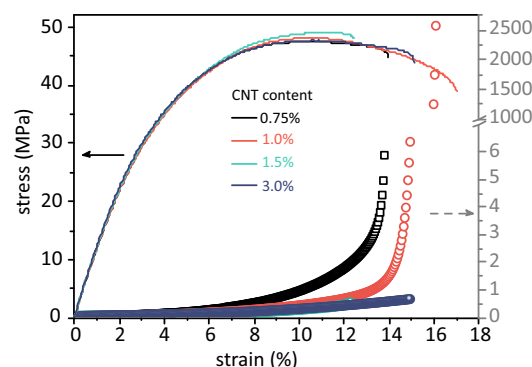
- mechanical deformations
- moisture
- solvents in liquid and vapor state
- and temperature changes



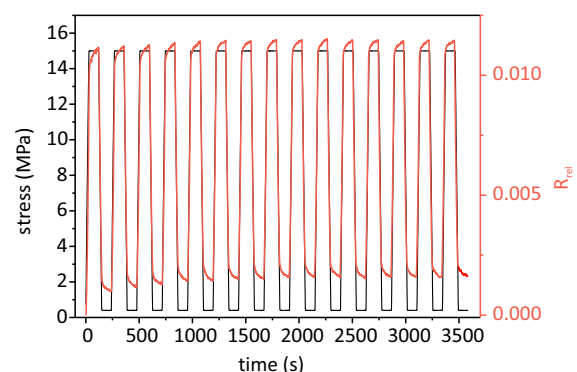
Sensing principle



Strain sensing

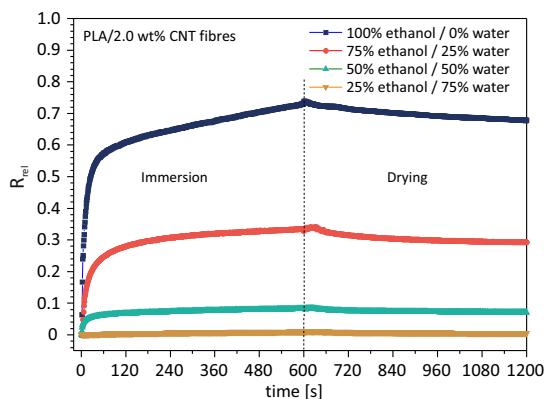


Electrical resistance change R_{rel} in stress-strain tests of PVDF composites with different CNT contents [1]



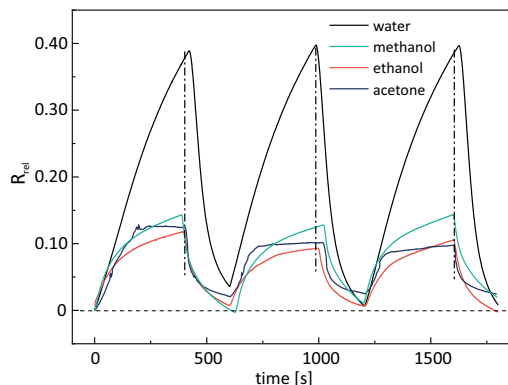
Electrical resistance change R_{rel} during cyclic testing of PVDF composite with 0.75 wt% CNT and 0.75 wt% clay [2]

Liquid sensing



Electrical resistance change R_{rel} of PLA/2 wt% CNT fibers during an immersion/drying cycle in ethanol/water mixtures [3]

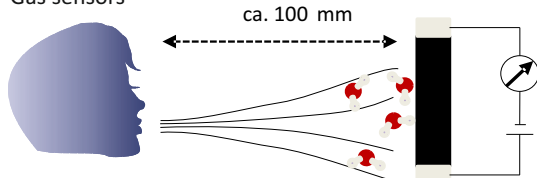
Sensors for gas



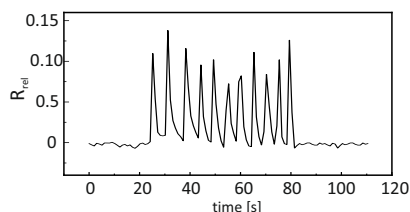
Electrical resistance change R_{rel} of cellulose aerogel films with 5 wt% rGO (reduced graphene oxide) vs. different saturated vapors [4]

Applications

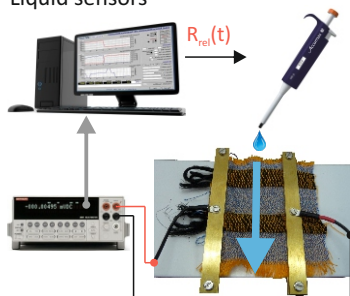
Gas sensors



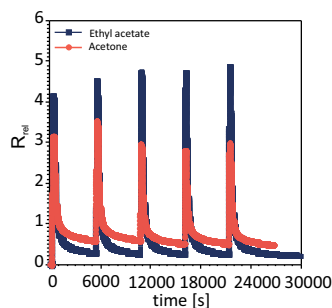
Vapor sensing: Real-time monitoring for human exhaled breath using cellulose films with 5 wt% rGO [4]



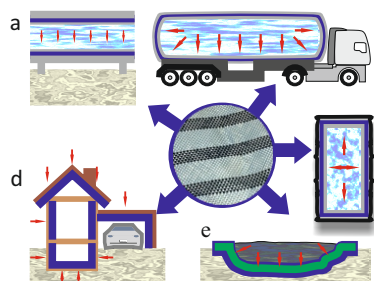
Liquid sensors



Sensing textile, wetting scenario and experimental setup for the determination of the electrical resistance change



Electrical response R_{rel} characteristics of a sensing textile, based on blend composite and cotton fibres in contact with ethyl acetate and acetone



Sensing textile for leakage detection in piping systems (a), tanks (b,c) and in construction engineering (d,e)

References

- [1] K. Ke, P. Pötschke, N. Wiegand, B. Krause and B. Voit, Tuning the Network Structure in Poly(vinylidene fluoride)/Carbon Nanotube Nanocomposites Using Carbon Black: Toward Improvements of Conductivity and Piezoresistive Sensitivity, ACS Appl. Mater. Interfaces, 2016, 8 (22), 14190–14199.
- [2] K. Ke (2016). Piezoresistive behavior of carbon nanotube based poly(vinylidene fluoride) nanocomposites towards strain sensing applications. Doctor thesis. TU Dresden, Germany.
- [3] P. Pötschke, T. Andres, T. Villmow et al., Liquid sensing properties of fibers prepared by melt spinning from PLA containing MWNT, Composites Science and Technology, 2010, 70 (2), 343–349.
- [4] Y. Chen, P. Pötschke, J. Pionteck, B. Voit, H. Qi, Smart cellulose/graphene composites fabricated by in-situ chemical reduction of graphene oxide for multiple sensing applications, Journal of Materials Chemistry A, 2018, 6, 7777 – 7785.
- [5] T. Villmow, S. Pegel, A. John, R. Rentenberger and P. Pötschke, Liquid sensing: smart polymer/CNT composites, Materials Today, 2011, 14 (7-8), 114–119

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