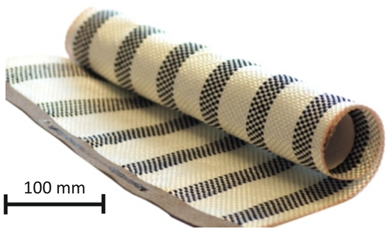
Leibniz-Institut
für Polymerforschung
Dresden

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

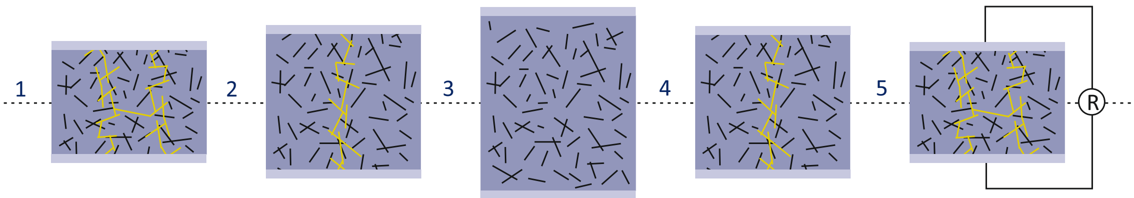
**Electrically conductive polymer composites (CPCs) are multifunctional materials and can be used for the detection of environmental influences due to their sensory properties.**
**The use of electrically conductive carbon nanotubes (CNTs) and other conductive carbon nanoparticles (CNPs) is particularly suitable.**

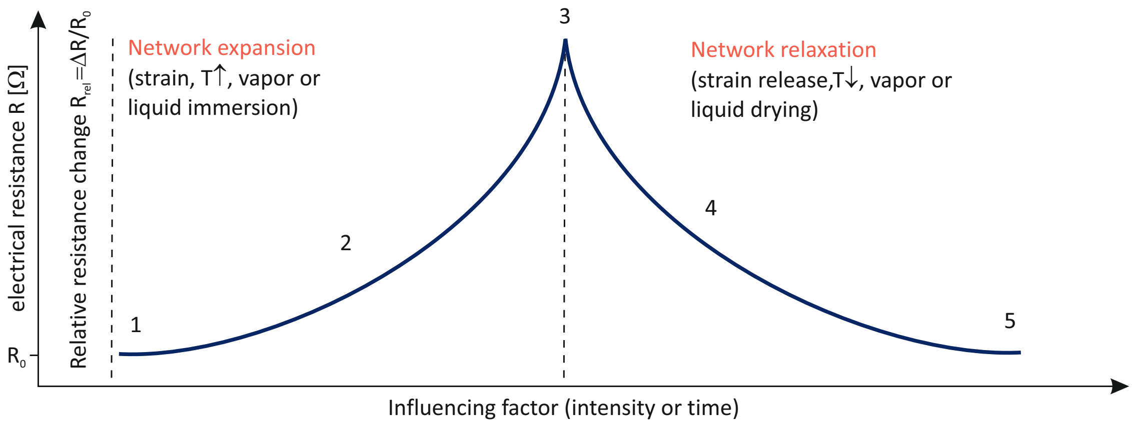
Due to interactions of the CPCs with the environment, changes can occur in the structure of the conductive filler networks which lead to changes in the electrical resistance ΔR of the CPC.
This allows to detect:

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

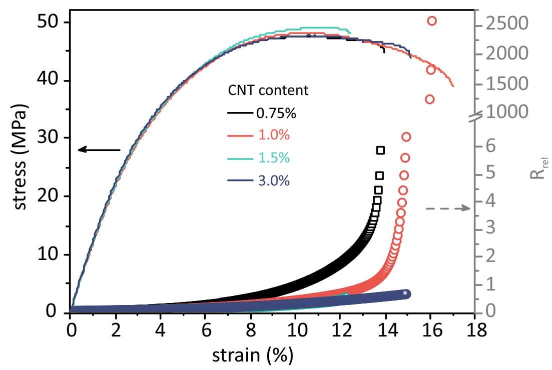



## Sensing principle

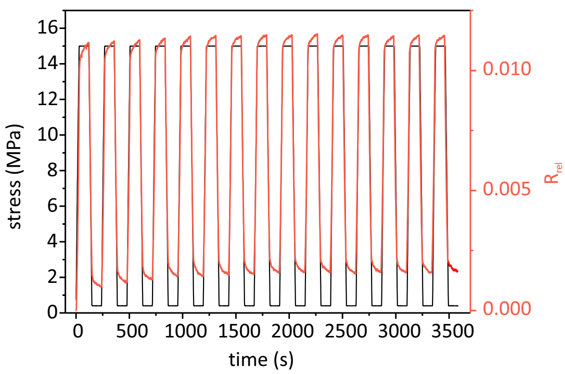



## Strain sensing

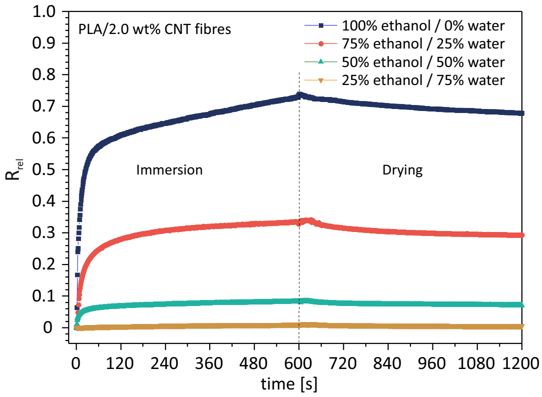



*Electrical resistance change $R_{rel}$ in stress-strain tests of PVDF composites with different CNT contents [1]*



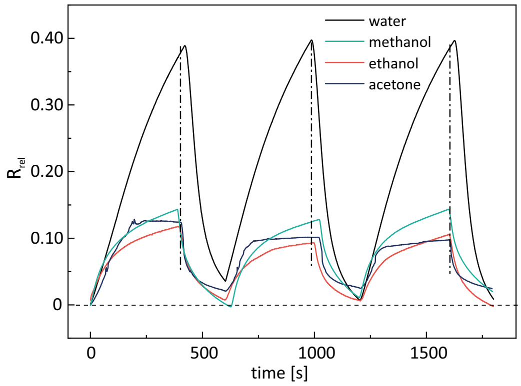

*Electrical resistance change $R_{rel}$ during cyclic testing of PVDF composite with 0.75 wt% CNT and 0.75 wt% clay [2]*

## Liquid sensing




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

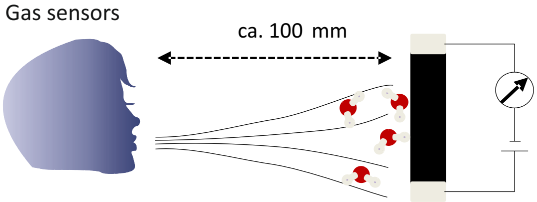
## Sensors for gas

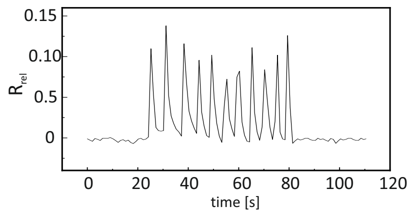



*Electrical resistance change $R_{rel}$ of cellulose aerogel films with 5 wt% rGO (reduced graphene oxide) vs. different saturated vapors [4]*

## Applications

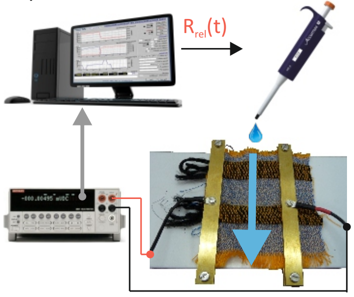
Gas sensors



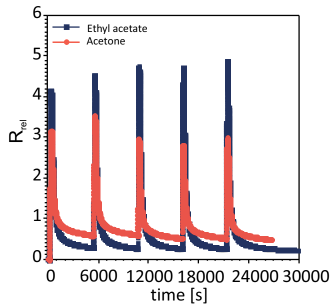




*Vapor sensing: Real-time monitoring for human exhaled breath using cellulose films with 5 wt% rGO [4]*

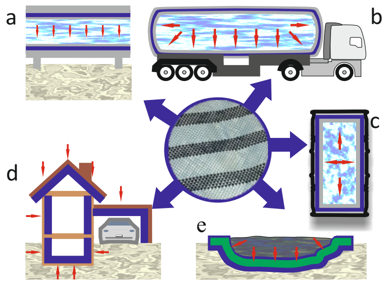
Liquid sensors




*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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