Leibniz-Institut
für Polymerforschung
Dresden

DRESDEN concept

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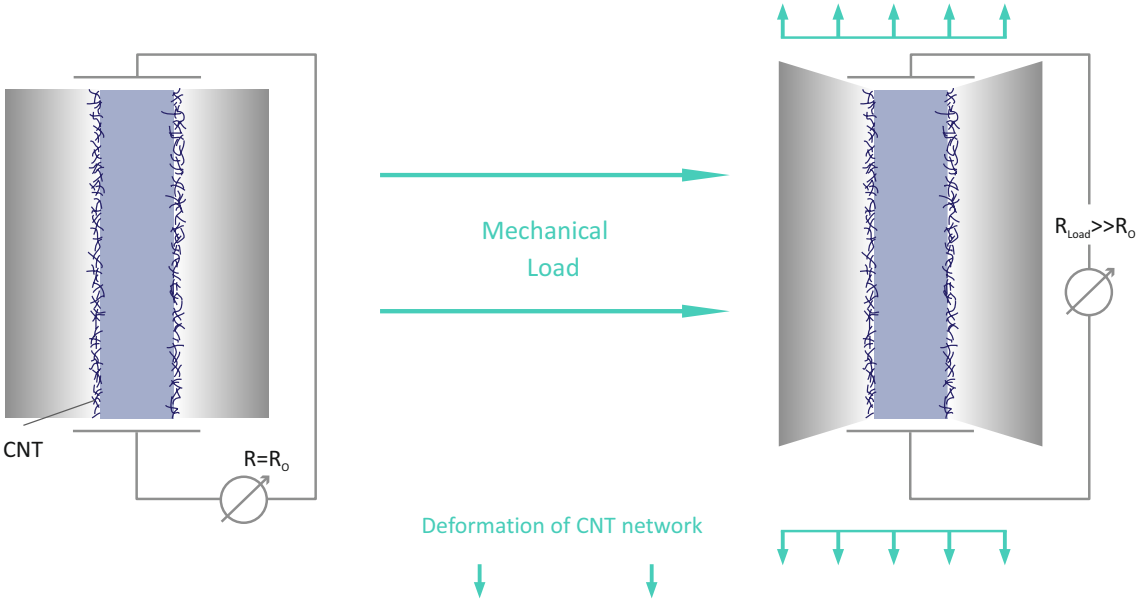
IN-SITU STRUCTURAL HEALTH MONITORING OF GLASS FIBRE REINFORCED THERMOPLASTICS Using Functional Interphases

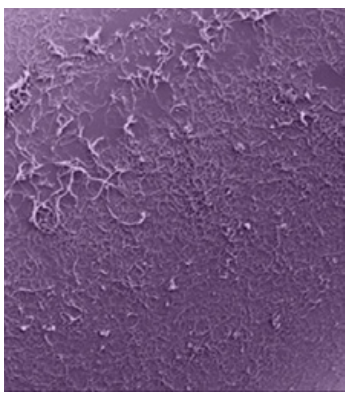
Motivation

Interphases in fibre-reinforced composites are vital regions for the stress transfer between fibres and surrounding matrix. Adding a percolated carbon nanotube network into the composites interphases allows the detection of mechanical stress strain behaviour by monitoring its electrical response. The change in electrical resistance is a quantitative measure of the deformation as well as of early stage damage formation in this highly loaded region. Online resistance measurements on functionalized composites allow detecting of interphase failure or glass fibre breakage prior to ultimate structural failure, enabling Structural Health Monitoring.

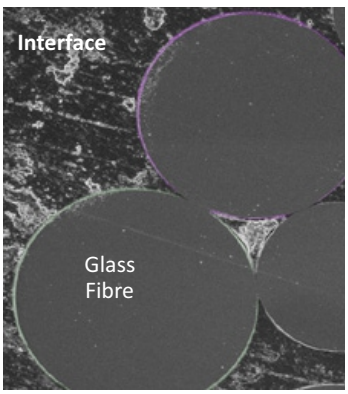
Cakes of CNT nanostructured glass fibres

Functional principles

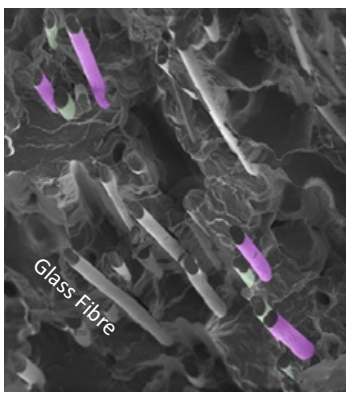




CNT-nanostructured glass fibre surface



Nanostructured interface

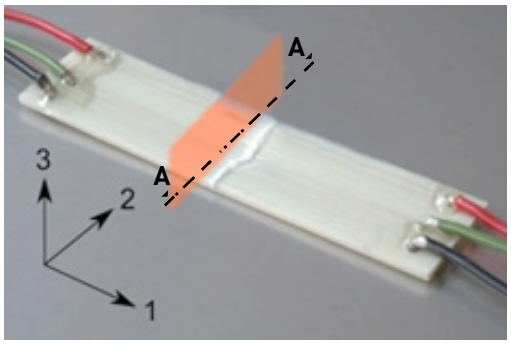


Fibres in a polymer matrix

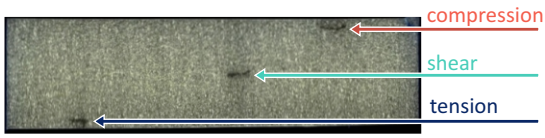
Benefits

In the case of Structural Health Monitoring, reinforcing fibres are substituted by sensor fibres (e.g. carbon, piezo-resistive ceramics or bragg gratings). Our approach concentrates on the interphase itself rather than on the filament. Thus, the sensitivity is not a given material constant of the fibre, but can be tailored to needs of the interfacial functionalization. In comparison to other techniques, the mechanical performance of the composite is not adversely affected by the sensor. For data acquisition and further processing, no complex signal amplifiers or processing algorithms are required. A simple ohmmeter fulfils all requirements.

Electro-mechanical response behavior

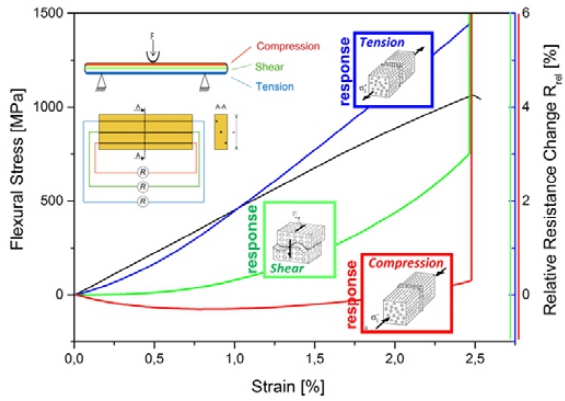


Cut A-A



Cross-section of unidirectional glass fibre reinforced thermoplastics with embedded CNT-sensors

3-point bending test



References

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[2] Zhang, J.; Zhuang, R.-C.; Liu, J.; Scheffler, C.; Mäder, E.; Heinrich, G.; Gao, S.-L.: A single glass fiber with ultrathin layer of carbon nanotube networks beneficial to in-situ monitoring of polymer properties in composite interphases. Soft Materials 12, 2014, 115

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state as of: May 2021