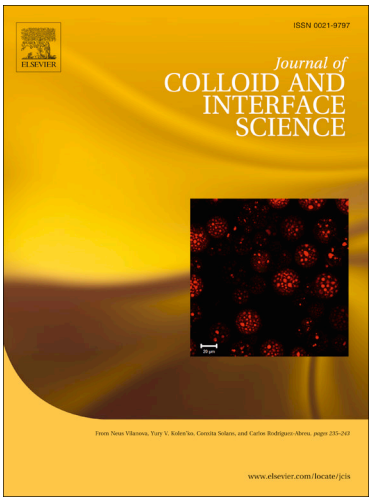

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PII: S0021-9797(17)30852-4
DOI: http://dx.doi.org/10.1016/j.jcis.2017.07.085
Reference: YJCIS 22614

To appear in: *Journal of Colloid and Interface Science*

Received Date: 29 March 2017
Revised Date: 4 July 2017
Accepted Date: 22 July 2017

Please cite this article as: C. Leopold, T. Augustin, T. Schwebler, J. Lehmann, W.V. Liebig, B. Fiedler, Influence of carbon nanoparticle modification on the mechanical and electrical properties of epoxy in small volumes, *Journal of Colloid and Interface Science* (2017), doi: http://dx.doi.org/10.1016/j.jcis.2017.07.085

Influence of carbon nanoparticle modification on the mechanical and electrical properties of epoxy in small volumes

Christian Leopold[a,*], Till Augustin[a], Thomas Schwebler[a], Jonas Lehmann[a], Wilfried V. Liebig[b], Bodo Fiedler[a]

[a] *Hamburg University of Technology, Institute of Polymer Composites, Denickestrasse 15, D-21073 Hamburg, Germany*
[b] *Karlsruhe Institute of Technology (KIT), Institute of Vehicle System Technology, Rintheimer Querallee 2, D-76131 Karlsruhe, Germany*

Abstract

The influence of nanoparticle morphology and filler content on the mechanical and electrical properties of carbon nanoparticle modified epoxy is investigated regarding small volumes. Three types of particles, representing spherical, tubular and layered morphologies are used. A clear size effect of increasing true failure strength with decreasing volume is found for neat and carbon black modified epoxy. Carbon nanotube (CNT) modified epoxy exhibits high potential for strength increase, but dispersion and purity are critical. In few layer graphene modified epoxy, particles are larger than statistically distributed defects and initiate cracks, counteracting any size effect. Different toughness increasing mechanisms on the nano- and micro-scale depending on particle morphology are discussed based on scanning electron microscopy images. Electrical percolation thresholds in the small volume fibres are significantly higher compared to bulk volume, with CNT being found to be the most suitable morphology to form electrical conductive paths. Good correlation between electrical resistance change and stress strain behaviour under tensile loads is observed. The results show the possibility to detect internal damage in small volumes by measuring electrical resistance and therefore indicate to the high potential for using CNT modified polymers in fibre reinforced plastics as a multifunctional, self-monitoring material with improved mechanical properties.

Keywords: Sensing, Percolation behaviour, Fractography, Structural health monitoring, True failure strength, Damage mechanisms

*Corresponding author
Email addresses: christian.leopold@tuhh.de (Christian Leopold), till.augustin@tuhh.de (Till Augustin), thomas.schwebler@tuhh.de (Thomas Schwebler), jonas.lehmann@tuhh.de (Jonas Lehmann), wilfried.liebig@kit.edu (Wilfried V. Liebig), fiedler@tuhh.de (Bodo Fiedler)