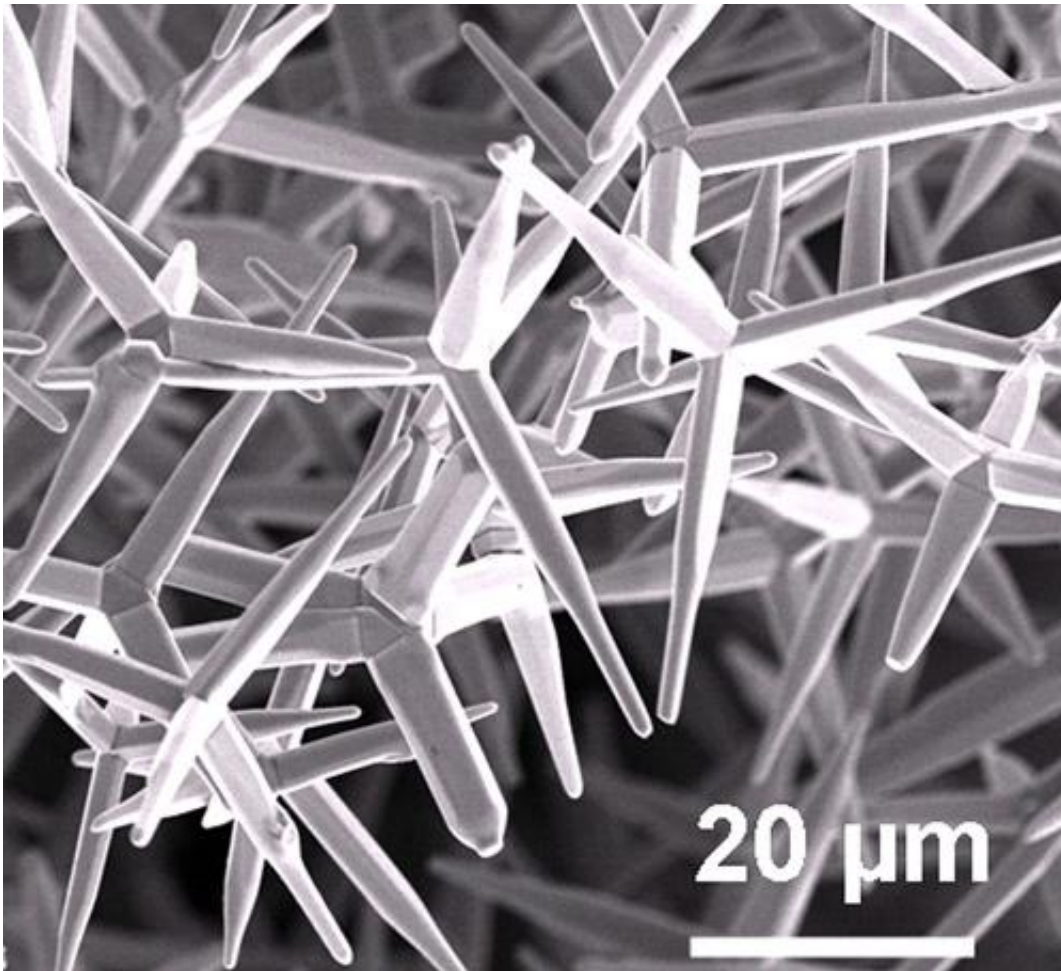


Predicting fatigue: Nanocrystals reveal damaged material

November 29 2012

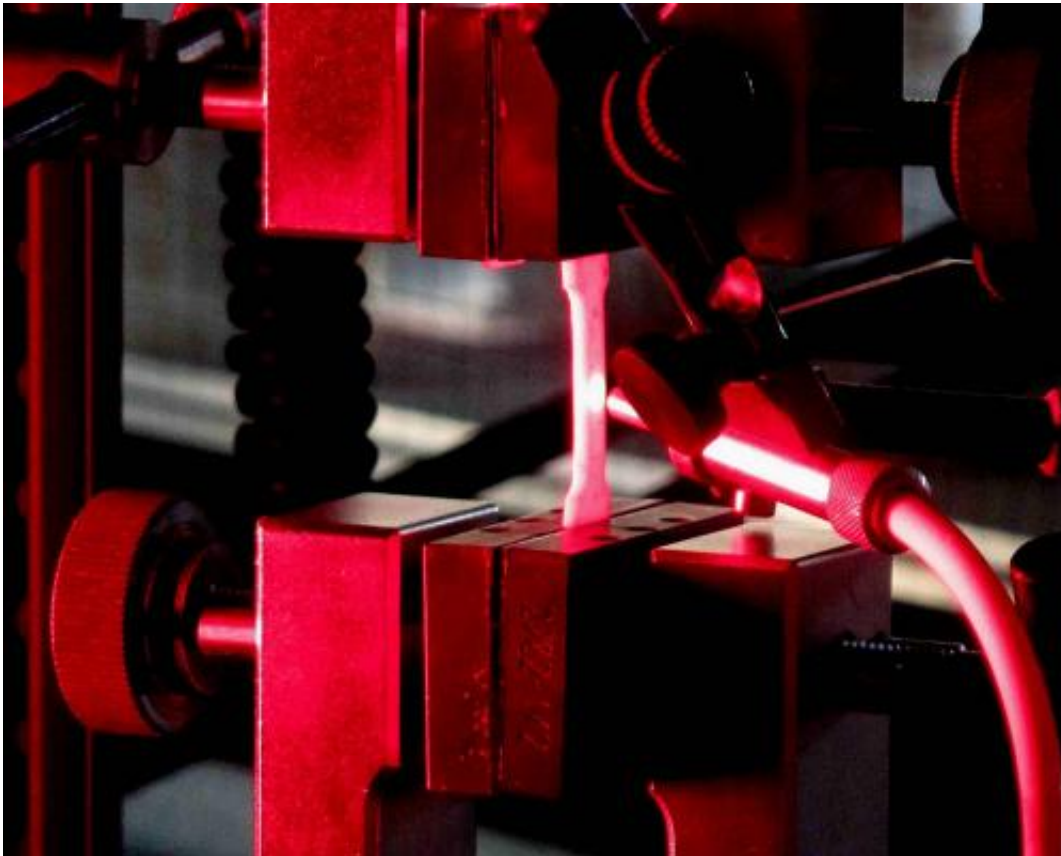


This is a picture of zinc oxide tetrapods taken by scanning electron microscope. Credit: Picture of zinc oxide tetrapods taken by scanning electron microscope - Copyright 2012, Wiley; reproduced with permission (DOI:10.1002/adma.201203849)

A small crack in a metal wheel caused Germany's worst-ever rail accident—the 1998 Eschede train disaster. The problem: it was practically impossible to detect damage of that nature to a metal by inspecting it externally. But now scientists have succeeded in making material fatigue visible. They designed new synthetic materials that emit light to report high mechanical stress.

The scientists of Kiel University, University of Erlangen-Nuremberg and the Technische Universität München (TUM) have published their results in the current issue of the journal *Advanced Materials*.

"The luminescent features of [zinc oxide](#) tetrapod crystals are well established. According to our work hypothesis, these characteristics showed pronounced variations under a mechanical load, and we realised that it could help to detect internal damages of composite materials", says Dr. Yogendra Mishra of Kiel University's Technical Faculty. In one experiment, the scientists added zinc oxide tetrapod shaped crystals to a silicone (polydimethylsiloxane) polymer and tested its general properties. They found that the resulting composite material is on the one hand stronger than silicon and on the other hand emits light in different colors when exposed to UV light. When the material is subjected to [mechanical stress](#), the intensities of the emitted lights changes.



The experimental setup shows how the composite material was stretched and exposed to light. At the same time, the reflecting light was measured. Credit: Copyright 2012, Wiley; reproduced with permission (DOI:10.1002/adma.201203849)

"The micro-nano sized crystals give a visual warning when the [composite material](#) is about to fail under stress", explains PhD student Xin Jin. "The alteration of the luminescent characteristics of defined semiconductor microstructures under load – as we could show for zinc oxide [tetrapods](#) – might be also interesting of many other phosphor material systems", adds Professor Cordt Zollfrank who leads the research area 'biogeneous polymers' at TUM. "We expect further interesting developments in this emerging field on "self-reporting materials".

Composite [polymer materials](#) are used in diverse fields from [dental implants](#) to spacecrafts. They are made from two or more constituent materials with different properties such as silicone and zinc oxide crystals which together render better properties. On demands, they can be designed to be light-weight, mechanically robust and still inexpensive. Professor Rainer Adelung, leader of the study, says: "Zinc oxide crystals seem to be an excellent component to design numerous specific composite materials – also for constructions in which stability is critical to life."

More information: Xin Jin, Michael Götz, Sebastian Wille, Yogendra Kumar Mishra, Rainer Adelung, Cordt Zollfrank (2012): A novel concept for self-reporting materials: Stress sensitive photoluminescence in ZnO tetrapod filled elastomers, *Advanced Materials*, doi: adma.201203849

Provided by Technical University Munich

Citation: Predicting fatigue: Nanocrystals reveal damaged material (2012, November 29)
retrieved 25 April 2024 from
<https://phys.org/news/2012-11-fatigue-nanocrystals-reveal-material.html>

<p>This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.</p>
--