Nanotubes key to microscopic mechanics

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In the latest issue of Elsevier's *Materials Today*, researchers from Spain and Belgium reported on the innovative use of carbon nanotubes to create mechanical components for use in a new generation of micro-machines. While the electronics industry has excelled in miniaturizing components, with individual elements approaching the nanoscale (or a billionth of a meter), reducing the size of mechanical systems has proved much more challenging.

One of the difficulties of shrinking mechanical devices is that the conventional techniques used to produce individual components are not useful when it comes to creating intricate shapes on the microscale. One promising technique is electrical discharge machining (EDM), which uses a spark of electricity to blast away the unwanted material to create complex shapes. However, this method requires that the target material is electrically conductive, limiting the use of EDM on hard, ceramic materials.

But now, by implanting carbon nanotubes in silicon nitride, the ceramic of choice, Manuel Belmonte and colleagues have been able to increase the electrical conductivity of the material by 13 orders of magnitude and have used EDM to produce a microgear without compromising the production time or integrity of the apparatus.

Carbon nanotubes rose to prominence in the early 1990s when their range of remarkable properties became apparent. These include phenomenal strength and electrical properties that can be tailored to suit. Each tube is made from a rolled up sheet of carbon atoms in a

honeycomb-like structure. Unrolled, this sheet is also known as graphene, the innovative material which was the subject of the 2010 Nobel Prize in Physics. Implanted inside a ceramic, these nanotubes form a conductive network that greatly reduces electrical resistance.

The electrical conductivity of the composite material is much higher, while the mechanical properties of the ceramic are preserved and wear resistance is significantly improved. As the corresponding author, Dr Manuel Belmonte, clarifies; this breakthrough will "allow the manufacture of intricate 3D components, widening the potential use of advanced ceramics and other insulating materials". The team hopes that such nanocomposite materials will find use in emerging applications, such as, microturbines, microreactors, and bioimplants.

More information: This article is "Carbon nanofillers for machining insulating ceramics" (doi: 10.1016/S1369-7021(11)70214-0) by Olivier Malek, Jesús González-Julián, Jef Vleugels, Wouter Vanderauwera, Bert Lauwers, Manuel Belmonte. It appears in Materials Today, Volume 14, Issue 10, Page 496 (2011)

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