Single-walled carbon nanotube composites show great promise for use in 'unconventional' computing

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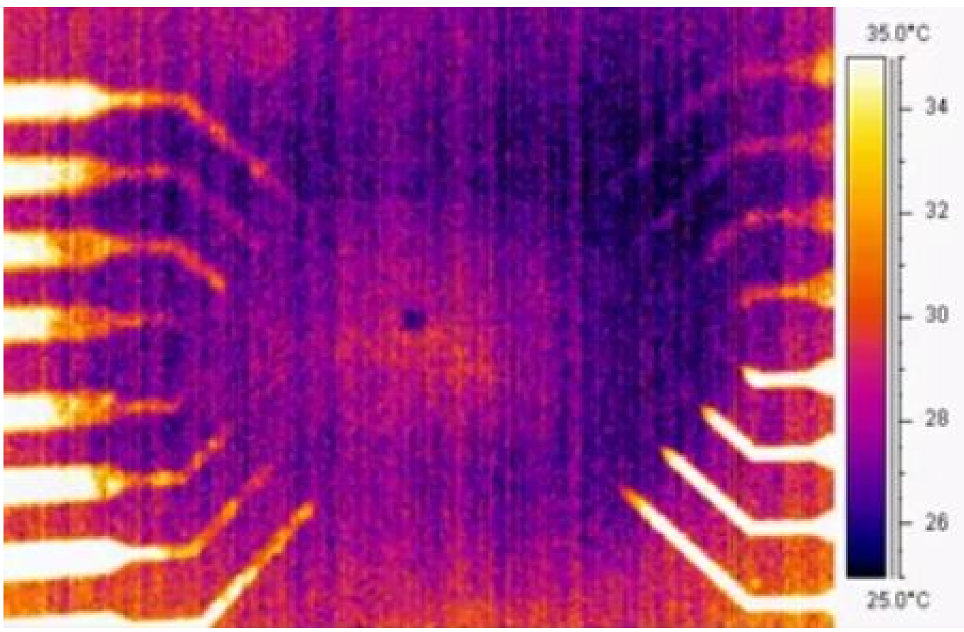

As we approach the miniaturization limits of conventional electronics, alternatives to silicon-based transistors—the building blocks of the multitude of electronic devices we've come to rely on—are being hotly pursued.

Inspired by the way living organisms have evolved in nature to perform complex tasks with remarkable ease, a group of researchers from Durham University in the U.K. and the University of São Paulo-USP in Brazil is exploring similar "evolutionary" methods to create information processing devices.

In the *Journal of Applied Physics*, from AIP Publishing, the group describes using single-walled carbon nanotube composites (SWCNTs) as a material in "unconventional" computing. By studying the mechanical and electrical properties of the materials, they discovered a correlation between SWCNT concentration/viscosity/conductivity and the computational capability of the composite.

"Instead of creating circuits from arrays of discrete components (transistors in digital electronics), our work takes a random disordered material and then 'trains' the material to produce a desired output," said Mark K. Massey, research associate, School of Engineering and Computing Sciences at Durham University.

This emerging field of research is known as "evolution-in-materio," a term coined by Julian Miller at the University of York in the U.K. What exactly is it? An interdisciplinary field blends together materials science, engineering and computer science. Although still in its early stages, the concept has already shown that by using an approach similar to natural evolution, materials can be trained to mimic electronic circuits—without needing to design the material structure in a specific way.

"The material we use in our work is a mixture of carbon nanotubes and polymer, which creates a complex electrical structure," explained Massey. "When voltages (stimuli) are applied at points of the material, its electrical properties change. When the correct signals are applied to the material, it can be trained or 'evolved' to perform a useful function."

While the group doesn't expect to see their method compete with highspeed silicon computers, it could turn out to be a complementary technology. "With more research, it could lead to new techniques for making electronics devices," he noted. The approach may find applications within the realm of "analog signal processing or low-power, low-cost devices in the future."

Beyond pursuing the current methodology of evolution-in-materio, the next stage of the group's research will be to investigate evolving devices as part of the material fabrication "hardware-in-the-loop" evolution. "This exciting approach could lead to further enhancements in the field of evolvable electronics," said Massey.

More information: "Computing with Carbon Nanotubes: Optimization of Threshold Logic Gates using Disordered Nanotube/Polymer Composites," by M.K. Massey, A. Kotsialos, F. Qaiser, D.A. Zeze, C. Pearson, D. Volpati, L. Bowen and M.C. Petty, *Journal of Applied Physics* on April 7, 2015: scitation.aip.org/content/aip/ … 13/10.1063/1.4915343

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