412 MAYNARD STREET
ANN ARBOR, MI
48109-1399
PHONE: (734)764-7260
FAX: (734) 764-7084

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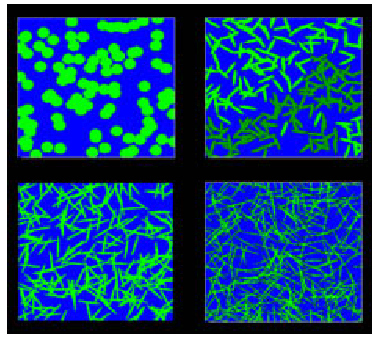
Researchers develop new method of mapping percolation



ANN ARBOR, Mich.— Researchers have developed a mathematical technique to determine the amounts of oddly shaped particles needed to percolate, or form clusters, big enough to conduct electricity or heat.

These University of Michigan findings could improve design of a huge range of products and materials, ranging from batteries to biological sensors inside human cells.

A paper, co-authored by Yun Bo-Yi, assistant research scientist in mechanical engineering, and Ann Marie Sastry, associate professor in mechanical engineering and biomedical engineering, will be published July 8 in the Proceedings of the Royal Society of London. The paper is titled: "Analytical Approximation of the Percolation Threshold for Overlapping Ellipsoids of Revolution."

Current analytical methods of determining percolation thresholds only apply to simply shaped particles, such as sticks, circles or spheres, Sastry said, leaving researchers with little choice of directly simulating, or performing large computations, to determine the percolation properties of other shapes.

Sastry

"And most particles that we would like to study are not so simple," Sastry said. She and Yi developed a technique to determine the percolation threshold for "stretched-out" spheres called ellipsoids.

The range of applications is huge, from helping scientists decide what to put into structural materials like cement to developing energy-storing materials such as batteries, to understanding biological phenomena such as how ions flow in cells. Another important aspect of the percolation research is that it helps scientists design experiments, for example, in determining how many sensors are needed to accurately detect ions in cells.

It's very important to understand and quantify the motion of rare but critical ions in cells, Sastry said, because they regulate or impact so many functions in the body. Putting sensors in cells is a way to detect that motion, but doing so can be tricky. Overloading the cell with sensors ruins the cell, but too few sensors and will not detect motion properly.

Support for the work was provided by Defense Advanced Research Projects Agency (DARPA) and the Office of Naval Research through the Synthetic Multifunctional Materials Program, managed by Leo Christodoulou of DARPA; the National Science Foundation through an NSF PECASE (Sastry); and the W.M. Keck Foundation.

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For further information, contact Ann Marie Sastry, (734) 764-3061, **amsastry@umich.edu** or Joshua Chamot , (703) 292-7730, **jchamot@nsf.gov**.

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Contact: Laura Bailey
Phone: (734) 647-7087 or 647-1848
E-mail: **baileylm@umich.edu**