Researchers study why metals fail

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(PhysOrg.com) -- The eventual failure of metals, such as the aluminum in ships and airplanes, can often be blamed on breaks, or voids, in the material's atomic lattice. They're at first invisible, only microns in size, but once enough of them link up, the metal eventually splits apart.

Cornell engineers, trying to better understand this process, have discovered that nanoscale voids behave differently than the larger ones that are hundreds of thousands of atoms in scale, studied through traditional physics. This insight could lead to improved ability to predict how cracks grow in metals, and how to engineer better materials.

Graduate student Linh Nguyen and Derek Warner, assistant professor of civil and environmental engineering, reported their findings in the journal Physical Review Letters, Jan. 20. Using new atomistic simulation techniques, they concluded that the smallest voids in these materials, those having nanometer dimensions, don't contribute in the same way as microscale voids do in material failure at ordinary room temperatures and pressures.

When metals fail, a physical phenomenon known as plasticity often occurs, permanently deforming, or changing the shape of the material. Previously, it was theorized that both nanometer and microscale voids grow via plasticity as the material fails, but the new research says otherwise.

"While this was something amenable to study with traditional atomistic modeling approaches, the interpretation of previous results was difficult due to a longstanding challenge of time scaling," Warner said. "We've come up with a technique to better address that."

Nguyen and Warner's work is supported by the Office of Naval Research, which has particular interest in the use of aluminum and other lightweight, durable metals in high-performance ship structures.

Provided by Cornell University

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