

March 05, 2010

## 2010-03-05: Unlocking the mysteries of crack formation

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### Recommended Citation

Eriksen, Jenny, "2010-03-05: Unlocking the mysteries of crack formation" (2010). *News@Northeastern*. Paper 527.  
<http://hdl.handle.net/2047/d20001770>

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## Unlocking the mysteries of crack formation



Karma examined how cracks form in different materials. Photo by Lauren McFalls.

**March 5, 2010**

In research published in the March 4 issue of the journal **Nature**, Northeastern University physicists have pioneered the development of large-scale computer simulations to assess how cracks form and proliferate in materials ranging from steel and glass to nanostructures and human bones.

For years, scientists have tried to understand the propagation of cracks and how they affect the materials in which they form, said **Alain Karma**, distinguished physics professor and lead investigator on the project.

“We now better understand what path cracks follow as they propagate in a stressed material,” said Karma, director of Northeastern’s **Center for Interdisciplinary Research on**

**Complex Systems**. “This knowledge will allow us to develop new materials — for advanced aircraft turbine blades, micro-electronic circuits and artificial bone — that better withstand destruction caused by cracks.”

Karma and the research team started out by examining the combined effects of two types of stress on crack propagation: shearing and tension. Shearing occurs naturally when material is twisted out of shape while tension occurs when material is pulled out of shape. The combination of shearing and tension causes crack instability. The mechanism for how this instability develops and spreads, however, remained elusive until Karma utilized the power of a computer.

Large-scale computer simulations yielded the surprising result that shearing and tension cause cracks to take the shape of a helix. Based on the simulation results, Karma and his team developed a theoretical equation to predict how the helix would rotate, expand and multiply in different materials.

“The fundamental question we are answering is how these cracks grow inside materials, said Karma. “Now that we have that information, we can develop new materials to withstand cracks, as well as more effectively reduce the damage of cracks once they form.”

The research could yield innovations in the production of lighter automobile and aircraft parts that reduce energy consumption, and composite artificial bones that will not fracture when inside the body. The results also have implications for understanding the evolution of geologic faults and fractures in the earth’s crust.

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