Scientists use low-gravity space station lab to study crystal growth

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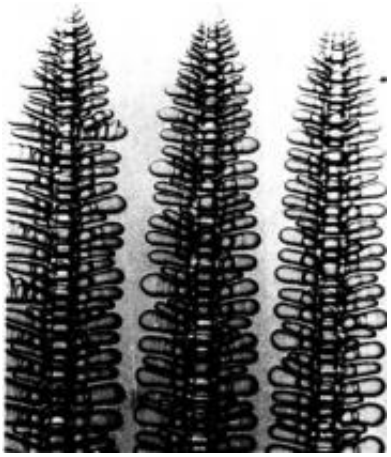

Ames Laboratory senior metallurgist Rohit Trivedi will be studying how crystals, such as these nickel-based superconductors, grow in low gravity experiments on board the International Space Station. Credit: USDOE's Ames Laboratory

A research project 10 years in the making is now orbiting the Earth, much to the delight of its creator Rohit Trivedi, a senior metallurgist at the U.S. Department of Energy's Ames Laboratory. Equipment recently delivered to the International Space Station by the Space Shuttle Discovery will allow the Earth-bound Trivedi to conduct crystal growth experiments he first conceived more than a decade ago.

The equipment is actually a mini laboratory, known as DECLIC - DEvice for the study of Critical LIquids and Crystallization - will allow

Trivedi to study and even control crystal growth pattern experiments, in real time, from his laboratory in Wilhelm Hall on the Iowa State University campus in Ames. The goal is to use the microgravity environment on board the Space Station to determine how materials form crystals as they move from liquid to solid and what effect variations in growth conditions have on crystallization patterns.

"When materials 'freeze' there are specific crystalline growth patterns that appear," Trivedi said, "and there are fundamental physics that govern these patterns. However, small effects can have significant influence on the patterns that form. Snow flakes, for example, form the same basic six-sided pattern, but because of minute variations, no two are exactly alike. These crystallization patterns play a critical role in governing the properties of a solidified material"

While Trivedi, who is also an ISU distinguished professor of materials science and engineering, studies primarily metals, the material to be used in the DECLIC experiments is a transparent, wax-like substance called succinonitrile. With a relatively low melting point, 57 degrees Celsius, the material lends itself to study in the controlled confines of the Space Station, and its transparency will make it possible for researchers to view the crystal growth process as the material solidifies. However, the basic principles governing crystal growth will be the same.

So why conduct the experiment in low gravity? Trivedi hopes that the low gravity will "erase" the effects of convection, the natural circulation of fluid.

"On Earth, the small effects are masked by convection," he said. "We hope that in a low-gravity environment, convection will be minimized so that we can more clearly see the importance of the small effects and see how the experimental data match our theoretical modeling."

Much of that modeling has been done by collaboration with Trivedi's colleague, Alain Karma, a theoretical physicist at Northeastern University in Boston. The pair has also collaborated closely with the Centre National d'Etudes Spatiales (CNES), the French government space agency that along with NASA, helped fund the work.

After preliminary testing in September, DECLIC is scheduled to be online in October and the first set of experiments will run through February 2010 according to Trivedi. Through a connection with the computation center in Toulouse, France, Trivedi's research group will be able to view video of the material as it solidifies. To pick up the necessary detail, Trivedi's lab is outfitted with a big-screen, high definition monitor. But they won't be just passive spectators.

"If we see something unusual, we can repeat the experiment, all in real time," Trivedi said. "Likewise, if we don't see much happening, we can alter the conditions and move on."

All the video from the DECLIC experiments will be captured and stored for future reference by CNES in Toulouse, France.

Trivedi's research proposal was originally selected by NASA for funding back in 1998, receiving approximately $2 million in total through ISU's Institute for Physical Research and Technology, and was later selected as one of only six projects in materials science selected for actual flight. To now be this close to seeing the project in operation is exciting for Trivedi.

"It's been a long time since we started," Trivedi said, "but it's also given us time to finalize the experiments and work on the theoretical side. Now we're just anxious to get experimental results to see if things behave as we expect."

Trivedi's research isn't the only Ames Laboratory science in outer space. Materials developed at the Lab's Materials Preparation Center are on board the Planck satellite as part of the instrument cooling system.

Source: Ames Laboratory (news : web)