Tiny Chip Demonstrates Big Memory in Cosmos

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A chemical alloy, used in everyday electronic items such as rewritable CDs and DVDs, serves as the source of a new computer chip which researchers hope will demonstrate non-volatile memory, or information storage retention without a power source, in the radiation-hardened space environment.

Debuting in 2000, the chalcogenide random access memory, or C-RAM, program, administered by the Air Force Research Laboratory's Space Vehicle Directorate, Kirtland Air Force Base, N.M., has invested in the innovative, tiny component, which features 16 times the retention capacity of the best non-volatile memory available for use in the cosmos.

"Today, we have to work around not having a dense, fast, non-volatile memory in our satellites," said Ken Hunt, senior electronic engineer and C-RAM program manager, Air Force Research Laboratory's Space Vehicles Directorate.

"Due to its unique way of retaining data, reasonably high endurance and ease of manufacturing, C-RAM will make an ideal non-volatile memory for space," he noted.

"The program's focus involves integrating chalcogenide phase-change material with standard radiation-hardened electronics to develop a memory that has high density, speed, and retention," he explained. "The C-RAM chip will also be radiation-hardened for optimum performance in space."

Defense satellites presently employ volatile forms of RAM to store most data. Although readily available and relatively high-performance, current hardware must be powered at all times or the data disappears.

On the other hand, commercially-produced non-volatile data retention, such as hard disks or flash memory, provide lasting backup storage, but cannot be reliably utilized in the harsh surroundings and vacuum of space.

Due to its high density and rapid speed, as well as to its low cost and inherent radiation hardness, C-RAM provides a ground-breaking alternative to space-based volatile memory.

"We are counting on C-RAM to be a key enabler in space electronics in the future," Hunt said. "It also provides a new tool for flexibility and reliability for the space electronics engineer."

"With this breakthrough technology, spacecraft system designers will no longer have to design around volatile memory; the power in a spacecraft could be cycled on and off, but the data will still be there," he emphasized.

"And we're also making sure that the chip will retain information across the huge temperature ranges experienced by satellites," Hunt further highlighted.

As a joint venture, the C-RAM part has been designed and developed by BAE Systems, Manassas, Va., and Ovonyx, Inc., Santa Clara, Calif. Funding has been provided by Air Force Research Laboratory and its Defense Department partners.

The reprogrammable technology involves a rather surprising procedure, in which nanoscale amounts of the chalcogenide material are melted to more than 1,100 degrees Fahrenheit. Cooled as either a glass or crystal, the memory bit stores data as a difference in resistivity.

In 2003, following a rapid material integration phase, the program constructed an array of 64,000 C-RAM memory bits, which demonstrated no cross heating of adjacent cells during operation, as well as verified radiation hardness.

The success of that experiment was followed by the development and prototyping of a four million bit chip. Product qualification of that design will continue until the end of 2007, and at that time, project personnel expect the C-RAM hardware to be ready for insertion in nearly every future satellite system.

"It has taken us a short six years to get to the point of design, development, and demonstration of the C-RAM chip." Hunt said. "C-RAM's ultimate impact will be improved data storage capability and increased onboard processing performance, which significantly contributes to efficient spacecraft operations and, ultimately, enhanced support to the warfighter."