Press Release

Tiny refrigerator taking shape to cool future computers

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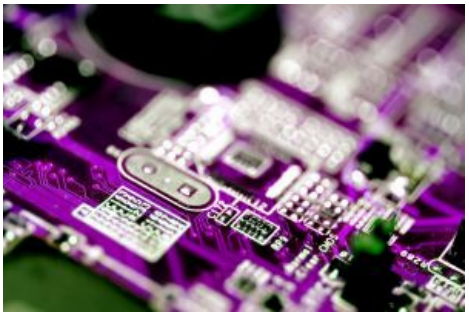

(Photo: Rodolfo Clix/Stock.XCHNG)

WEST LAFAYETTE, Ind. - Researchers at Purdue University are developing a miniature refrigeration system small enough to fit inside laptops and personal computers, a cooling technology that would boost performance while shrinking the size of computers.

Unlike conventional cooling systems, which use a fan to circulate air through finned devices called heat sinks attached to computer chips, miniature refrigeration would dramatically increase how much heat could be removed, said Suresh Garimella, the R. Eugene and Susie E. Goodson Professor of Mechanical Engineering.

The Purdue research focuses on learning how to design miniature components called compressors and evaporators, which are critical for refrigeration systems. The researchers developed an analytical model for designing tiny compressors that pump refrigerants using penny-size diaphragms and validated the model with experimental data. The elastic membranes are made of ultra-thin sheets of a plastic called polyimide and coated with an electrically conducting metallic layer. The metal layer allows the diaphragm to be moved back and forth to produce a pumping action using electrical charges, or "electrostatic diaphragm compression."

In related research, the engineers are among the first to precisely measure how a refrigerant boils and vaporizes inside tiny "microchannels" in an evaporator and determine how to vary this boiling rate for maximum chip cooling.

The research is led by Garimella and Eckhard Groll, a professor of mechanical engineering.

"We feel we have a very good handle on this technology now, but there still are difficulties in implementing it in practical applications," said Garimella, director of the Cooling Technologies Research Center based at Purdue. "One challenge is that it's difficult to make a compressor really small that runs efficiently and reliably."

Findings will be detailed in two papers being presented during the 12th International Refrigeration and Air Conditioning Conference and the 19th International Compressor Engineering Conference on July 14-17 at Purdue. The papers were written by doctoral students Stefan S. Bertsch and Abhijit A. Sathe, Groll and Garimella.

New types of cooling systems will be needed for future computer chips that will likely generate 10 times more heat than today's microprocessors, especially in small "hot spots," Garimella said.

Miniature refrigeration has a key advantage over other cooling technologies, Groll said.

More Technology

The ability to cool below ambient temperature could result in smaller, more powerful computers and also could improve reliability by reducing long-term damage to chips caused by heating.

One complication is that the technology would require many diaphragms operating in parallel to pump a large enough volume of refrigerant for the cooling system.

"So you have an array of 50 or 100 tiny diaphragm compressors, and you can stack them," Groll said.

The researchers conducted laboratory experiments with the diaphragms in Garimella's Thermal Microsystems Lab, developed a computational model for designing the compressor and validated the model with data from the lab. Findings showed that it is feasible to design a prototype system small enough to fit in a laptop, Garimella said.

The model enables the engineers to optimize the design, determining how many diaphragms to use and how to stack them, either parallel to each other or in series.

"If you stack in one direction, you get more pressure rise, and if you stack in the other direction, you get more volume pumped," Groll said.

Learning how to manufacture the devices at low cost is another major challenge, with industry requiring a cost of about $30 each.

"We can't currently produce them at this price, but maybe in the future," Groll said.

Another portion of the research focuses on learning precisely how refrigerant boils and turns into a vapor as it flows along microchannels thinner than a human hair. Such evaporators would be placed on top of computer chips.

Bertsch, the doctoral student who led work to set up experiments at the university's Ray W. Herrick Laboratories, observed how refrigerant boils inside the channels and measured how much heat is transferred by this boiling refrigerant. He also created mathematical equations needed to properly design the miniature evaporators.

"This overall project represents the first comprehensive research to carefully obtain data showing what happens to heat transfer in arrays of microchannels for miniature refrigeration systems and how to design miniature compressors," Garimella said. "Eventually, we will be able to design both the miniature compressors and evaporators."

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Purdue University: **http://www.purdue.edu/**

Thanks to Purdue University for this article.

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'Fingerprints' match molecular simulations with reality

A theoretical technique developed at the Department of Energy's Oak Ridge National Laboratory is bringing supercomputer simulations and experimental results closer together by identifying common "fingerprints."

Source: DOE/Oak Ridge National Laboratory | Views: 35 | **Comments: 0**

Compact high-temperature superconducting cables

A researcher at the National Institute of Standards and Technology (NIST) has invented a method of making high-temperature superconducting (HTS) cables that are thinner and more flexible than demonstration HTS cables now installed in the electric power grid while carrying the same or more current. The compact cables could be used in the electric grid as well as scientific and medical equipment and

Source: National Institute of Standards and Technology (NIST) | Views: 114 | **Comments: 0**

Engineering atomic interfaces for new electronics

Most people cross borders such as doorways or state lines without thinking much about it. Yet not all borders are places of limbo intended only for crossing. Some borders, like those between two materials that are brought together, are dynamic places where special things can happen.

Source: University of Wisconsin-Madison | Views: 126 | **Comments: 0**

Scientists use high 'NOON' microwave photons for quantum computing

An important step toward the realization of a large-scale quantum computer, and further demonstration of a new level of the quantum control of light, were accomplished by a team of scientists at UC Santa Barbara and in China and Japan.

Source: University of California - Santa Barbara | Views: 84 | **Comments: 0**

Video: New wireless technology for faster, more efficient networks

"Wireless communication is a one-way street. Over."

Source: Stanford University | Views: 73 | **Comments: 0**

X-rays show why van Gogh paintings lose their shine

Scientists have identified a complex chemical reaction responsible for the degradation of two paintings by Vincent van Gogh and other artists of the late 19th century. This discovery is a first step to understanding how to stop the bright yellow colours of van Gogh's most famous paintings from being covered by a brown shade, and fading over time.

Source: European Synchrotron Radiation Facility | Views: 50 | **Comments: 0**

Powerful new ways to electronically mine research may lead to scientific breakthroughs

The Internet has become not only a tool for disseminating knowledge through scientific publications, but it also has the potential to shape scientific research through expanding the field of metaknowledge—the study of knowledge itself.

Source: University of Chicago | Views: 87 | **Comments: 0**

Researchers produce world's first programmable nanoprocessor

Engineers and scientists collaborating at Harvard University and the MITRE Corporation have developed and demonstrated the world's first programmable nanoprocessor.

Source: Harvard University | Views: 211 | **Comments: 0**

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