

News

Articles

Videos

Images

Books

Health & Medicine

Mind & Brain

Plants & Animals

Earth & Climate

Space & Time

Matter & Energy

Computers & Math

Fossils & Ruins

Science News

Share Blog Cite

Print Bookmark Email

Micro-Pump Is Cool Idea For Future Computer Chips

ScienceDaily (Apr. 27, 2006) — Engineers at Purdue University have developed a tiny "micro-pump" cooling device small enough to fit on a computer chip that circulates coolant through channels etched into the chip.

See Also:

Matter & Energy

- [Microarrays](#)
- [Technology](#)
- [Nature of Water](#)

Computers & Math

- [Computer Science](#)
- [Mobile Computing](#)
- [Information Technology](#)

Reference

- [Heat pump](#)
- [Integrated circuit](#)
- [Microchip implant \(animal\)](#)
- [MRAM](#)

Innovative cooling systems will be needed for future computer chips that will generate more heat than current technology, and this extra heating could damage electronic devices or hinder performance, said Suresh Garimella, a professor of mechanical engineering.

The new device has been integrated onto a silicon chip that is about 1 centimeter square, or roughly one-sixth of a square inch. The technology is an example of a microelectromechanical system, or MEMS, a tiny mechanical device fabricated using methods generally associated with microelectronics.

"Because it's a MEMS pump, we were able to integrate the entire cooling system right onto a chip,"

Garimella said. "The most innovative part of the technology is the micro-pump."

An article about the cooling device will appear in the May issue of Electronics Cooling magazine. The article was written by doctoral student Brian D. Iverson, Garimella and former doctoral student Vishal Singhal, who recently graduated and co-founded Thorrn Micro Technologies Inc., in Redwood City, Calif.

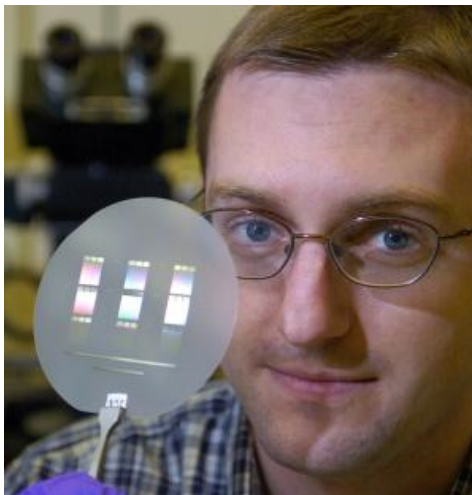
Chips in today's computers are cooled primarily with an assembly containing conventional fans and "heat sinks," or metal plates containing fins to dissipate heat. But because chips a decade from now will likely contain upwards of 100 times more transistors and other devices, they will generate far more heat than chips currently in use, Garimella said.

"Our goal is to develop advanced cooling systems that are self-contained on chips and are capable of handling the more extreme heating in future chips," said Garimella, director of Purdue's Cooling Technologies Research Center. The center, supported by the National Science Foundation, industry and Purdue, was formed to help corporations develop miniature cooling technologies for a wide range of applications, from electronics and computers to telecommunications and advanced aircraft.

The prototype chip contains numerous water-filled micro-channels, grooves about 100 microns wide, or about the width of a human hair. The channels are covered with a series of hundreds of electrodes, electronic devices that receive varying voltage pulses in such a way that a traveling electric field is created in each channel. The traveling field creates ions, or electrically charged atoms and molecules, which are dragged along by the moving field.

"Say every sixth electrode receives the same voltage, these varying voltages from one electrode to the next produce a traveling electrical field that pulls the ions forward, causing the water to flow and inducing a cooling action," Garimella said. "Essentially, you are pumping fluid forward."

This pumping action is created by a phenomenon called



Brian D. Iverson, a mechanical engineering doctoral student at Purdue, holds up a disk containing several "micro-pump" cooling devices small enough to fit on a computer chip. The tiny pumps circulate coolant through channels etched into the chip. (Purdue News Service photo/David Umberger)

Ads by Google

On-site Computer Repair
Affordable Same Day Service
Servicing Montgomery County, MD
www.1877geeksonsite.com

Custom Heatsinks
Our expert thermal engineers
are ready to assist you
www.cooliance.com

2-Phase Liquid Cooling
Increased power density, decreased
weight in a smaller footprint
www.parker.com/pc

Micronit Microfluidics
Prototyping and Manufacturing
of Lab-on-a-Chip devices.
www.micronit.com

Related Stories



Tiny Ion Pump Sets New Standard In Cooling Hot Computer Chips (Aug. 28, 2006) — University of Washington researchers have succeeded in building a cooling device tiny enough to fit on a computer chip that could work reliably and efficiently with the smallest microelectronic ... [> read more](#)



Chip-Cooling Technology Achieves 'Dramatic' 1,000-Watt Capacity (July 2, 2008) — Researchers have developed a technology that uses "microjets" to deposit liquid into tiny channels and remove five times more heat than other experimental high-performance chip-cooling methods for ... [> read more](#)

Just In:

[Cell Phones May Have Effect on Brain Activity](#)

Science Video News



Heart Surgery: Faster Recovery
Cardiologists weave an eight gram pump through an artery in the groin into the left ventricle, where it pumps up to five liters of blood per minute..
... [> full story](#)

[Electrical Engineers Envision Broad, Transformational Use of Flash Memory](#)

[Biomedical Engineers' 'Body-on-a-Chip' Could Reduce Cost of Developing New Drugs](#)

[Musician Puts Love for Computer Science into Minimalist Synthesizer](#)

[more science videos](#)

Breaking News ... from NewsDaily.com

[Russia to boost navigation satellite launch: Ifax](#)



[Cellphone calls alter brain activity: study](#)

[Baby dolphin deaths rise along Gulf Coast](#)

[CERN collider restarts search for cosmic mysteries](#)

[WSI sees mild weather for UK, cold for east Europe](#)

[more science news](#)

In Other News ...

[Police raid "pill mills" across south Florida](#)

[CBOE eyeing strategy in exchange merger dash](#)

[Fear stalks Tripoli as Libya's east celebrates](#)

[New Zealand quake toll 71, voice heard in rubble](#)

electrohydrodynamics, which uses the interactions of ions and electric fields to cause fluid to flow.

"Engineers have been using electrohydrodynamics to move fluids with electric fields for a long time, but it's unusual to be able to do this on the micro-scale as we have demonstrated," Garimella said.

The researchers also have added a feature to boost the force of the pumping action. A thin sheet of piezoelectric material, which expands and contracts in response to an electric current, was glued on top of the cover of the liquid-filled channels.

"This material acts as a diaphragm that deforms up and down when you give it a voltage, causing it to push additional flow through the channels," Garimella said. "We have developed mathematical models that show this piezo action enhances the electrohydrodynamic performance."

The diaphragm has enhanced the pumping action by 13 percent in the current prototype, but the modeling indicates a possible enhancement of 100 percent or greater, he said.

"Although electrohydrodynamics has generally not been considered practical for pumping applications due to the assumption that it requires a large amount of energy and does not produce enough motive force for thrust, the method has been shown to be far more efficient for micro-cooling applications," Garimella said. "We have shown that the power input required is in the microwatts, but you can get milliwatts of cooling. In other words, the cooling effect is more than a thousand times greater than the energy needed to drive the system. That's because all we need to do is create enough of a flow to induce cooling."

However, several major challenges remain.

"One big challenge is further developing mathematical models that are comprehensive and accurate because this is a very complicated, dynamic system," Garimella said. "You've got fluid flow on a micro-scale, you've got electrohydrodynamic effects, electrical fields and a moving diaphragm."

Other challenges include sealing the tiny channels to prevent water leakage and designing the system so that it could be manufactured under the same conditions as semiconductor chips.

The work has been funded by the Indiana 21st Century Research and Technology Fund. Garimella is a member of the Birk Nanotechnology Center at Purdue's Discovery Park.

Email or share this story: | [More](#)

Story Source:

The above story is reprinted (with editorial adaptations by ScienceDaily staff) from materials provided by [Purdue University](#).

Need to cite this story in your essay, paper, or report? Use one of the following formats:

- APA Purdue University (2006, April 27). Micro-pump Is Cool Idea For Future Computer Chips. *ScienceDaily*. Retrieved February 23, 2011, from <http://www.sciencedaily.com/releases/2006/04/060426183753.htm>
- MLA

Note: If no author is given, the source is cited instead.

Disclaimer: Views expressed in this article do not necessarily reflect those of ScienceDaily or its staff.

Steering Toward The Much-Discussed Lab-on-a-Chip (Dec. 18, 2006) — Scientists are reporting discovery of technology that may simplify construction of those much-discussed Micro Total Analysis Systems (micro-TASs) -- "labs-on-a-chip" with whole medical and scientific ... > [read more](#)



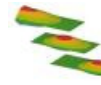
Tiny Refrigerator Taking Shape To Cool Future Computers (June 24, 2008) — Researchers are developing a miniature refrigeration system small

enough to fit inside laptops and personal computers, a cooling technology that would boost performance while shrinking the size of ... > [read more](#)



Medical Micropump: Device May Aid Development Of 'Lab On A Chip' (Nov. 14, 2006) — Using material similar to bathtub caulk, University of Utah engineers

invented a tiny, inexpensive "micropump" that could be used to move chemicals, blood or other samples through a card-sized ... > [read more](#)



Smart Miniature Pump Could Deliver Medicine (May 7, 2008) —

An innovative micro-pump makes it possible for tiny quantities of liquid -- such as medicines -- to be dosed accurately and flexibly. Active composites and an electronic control mechanism ensure that ... > [read more](#)



New Findings Could Help Hybrid, Electric Cars Keep Their Cool

(Sep. 23, 2009) — Understanding precisely how fluid boils in tiny "microchannels" has led to formulas and models that will help engineers design systems to cool high-power electronics in electric and hybrid cars, ... > [read more](#)

'USB' Interface for Medical Diagnosis? (Dec. 3, 2010) — Biomedical engineers have developed a plug-in interface for the microfluidic chips that will form the basis of the next generation of compact medical devices. They hope that the "fit to flow" ... > [read more](#)

Ads by Google

Thermic Earth

Geothermal heating and air conditioning
www.thermicearth.com

Number of stories in archives: 98,536

U.S. oil soars as high as \$100 on Libya unrest

Apple feels shareholder heat over Jobs succession

Obama pulls defense for law banning gay marriage

Cables show Libya pressed oil firms to reimburse terror costs

[more top news](#)

Ads by Google

2-Phase Liquid Cooling

Increased power density, decreased weight in a smaller footprint
www.parker.com/pc

Microfluidic Lab on chip

Pressure or flow control? Don't choose... take both!
www.fluigent.com/maesflo.htm

Heat Pump

Heat Pump Systems For Less Free Shipping (On Sale Now)
www.PayLessAC.Com

Thermic Earth

Geothermal heating and air conditioning
www.thermicearth.com

Keep Warm with Sears

Save \$325 on a New Furnace! Keep Warm this Winter & Save with Sears
SearsHomeServices.com

Copyright Reuters 2008. See [Restrictions](#).

Free Subscriptions ... from ScienceDaily

Get the latest science news with our free email newsletters, updated daily and weekly. Or view hourly updated newsfeeds in your RSS reader:

[Email Newsletters](#)

[RSS Newsfeeds](#)

Feedback ... we want to hear from you!

Tell us what you think of ScienceDaily -- we welcome both positive and negative comments. Have any problems using the site? Questions?

Your Name:

Your Email:

Comments:

Click button to submit feedback:

Find with keyword(s):

Enter a keyword or phrase to search ScienceDaily's archives for related news topics, the latest news stories, reference articles, science videos, images, and books.

