« NAVIGATION »

NEWS
- Bio/Medicine
- Chemicals
- Defense
- Drug Delivery
- Electronics
- Energy
- Events
- Industry
- Litigation
- Materials
- MEMS
- Microscopes
- Partnership
- Patent
- Products
- Research
- Venture Capital / Investment

BOOKS
COMPANIES
FEEDBACK
ADVERTISE
LINK TO US

XML RSS

« NEWSLETTER »
your email here
SUBSCRIBE

« SEARCH »
SEARCH

4/2/2004 7:15:57 PM

Nano-lightning To Create Tiny Wind Currents To Cool Future Computers

Mechanical engineers at Purdue University are developing a new type of cooling technology for computers that uses a sort of nano-lightning to create tiny wind currents.

The researchers have shown that the underlying concept for a "micro-scale ion-driven airflow" device is sound and have recently filed for a patent.

"This is a groundbreaking idea," said Suresh Garimella, a professor of mechanical engineering at Purdue who is working on the device with Timothy Fisher, an associate professor of mechanical engineering, Daniel J. Schlitz , who recently earned a doctoral degree from Purdue, and doctoral student Vishal Singhal. Schlitz and Singhal have created Thorrn Micro Technologies Inc. to commercialize the cooling system.

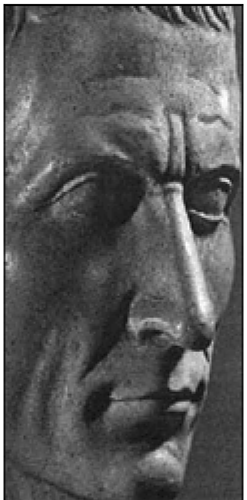
Future computer chips will contain more circuitry and components, causing them to generate additional heat and requiring innovative cooling methods. Engineers are studying ways to improve cooling technologies, including systems that circulate liquids to draw heat from chips.

Using a liquid to cool electronic circuits, however, poses many challenges, and industry would rather develop new cooling methods that use air, Garimella said.

"The key attribute of this work is that it sticks with air cooling while possibly providing the same rate of cooling as a liquid," he said.

The new technique works by generating ions – or electrically charged atoms – using electrodes placed close to one another on a computer chip. Negatively charged electrodes, or cathodes, are made of "nanotubes" of carbon with tips only as wide as five nanometers, or billionths of a meter.

Voltage is passed into the electrodes, causing the negatively charged nanotubes to discharge electrons toward the positively charged electrodes. The electrons react with surrounding air, causing the air molecules to be ionized just as electrons in the atmosphere ionize air in clouds. This ionization of air leads to an imbalance of



charges that eventually results in lightning bolts.

The ionized air molecules cause currents like those created by the "corona wind" phenomenon, which happens between electrodes at voltages higher than 10 kilovolts, or 10,000 volts.

"To create lightning you need tens of kilovolts, but we do it with 100 volts or less, " Garimella said. "In simple terms, we are generating a kind of lightning on a nano-scale here."

The researchers are able to create the ionizing effect with low voltage because the tips of the nanotubes are extremely narrow and the oppositely charged electrodes are spaced apart only about 10 microns, or one-tenth the width of a human hair.

Future cooling devices based on the design will have an "ion-generation region," where electrons are released, and a "pumping region," made up of another set of electrodes needed to create the cooling effect.

Clouds of ions created when electrons react with air can then be attracted by the second region of electrodes and "pumped" forward by changing the voltages in those electrodes. The voltages are rapidly switched from one electrode to the next in such a way that the clouds of ions move forward and produce a cooling breeze.

"They are switching at the right frequency so that the ion cloud is constantly moving forward," Schlitz said. "As the ions move forward, they make repeated collisions with neutral molecules, producing the breeze."

The Purdue researchers have demonstrated that the pumping concept works with a region of electrodes made of many series, each series containing three electrodes. The first in the series is the most positively charged, followed by an electrode that has a less-positive charge and then a third electrode that is negative.

Switching the voltages from one electrode to the next causes the charges to move forward, which in turn moves the ion clouds.

"The switching itself is a well-known concept from physics, but we are the first to bring about ion pumping on a micro-scale like this," said Garimella, who is director of Purdue's Cooling Technologies Research Center, a consortium of corporations, university and government laboratories working to overcome obstacles in developing new, compact cooling technologies.

"This is a very novel idea," he said. "It is certainly one of the most inventive things I've ever been involved with."

More work must be done to perfect the technique and develop a prototype, the researchers said.

"Right now it's a laboratory-scale phenomenon," Schlitz said.

Another version of the design might replace the carbon nanotubes with a thin film of diamond, which would be sturdier and easier to fabricate than the nanotubes.

"The grain boundaries in the diamond film provide the same kind of opportunity for electron emission and ion generation as a carbon nanotube," Garimella said.

The researchers envision cooling devices that are small enough to fit on individual chips, actually making up a layer of the chip.

"The entire thing would sit on, and be integrated into, a chip that is 10 millimeters by 10 millimeters," Garimella said.

Chips in desktop computers currently are cooled with "heat sinks" that contain fins to dissipate heat. The heat sinks are connected to bulky fan assemblies to carry away the heated air.

"You need an external means of creating air," Garimella said. "That's important. You need the fan.

"Here, the creation of air as well as the cooling is all happening on one chip. That's the key value of this idea."

If the method can be perfected, it will introduce a major new cooling technology for laptop and desktop computers that is quiet, low-cost and reliable, said Fisher, whose work focuses on fabrication of the carbon-nanotube and diamond-film electrodes, as well as testing the device's ion-generation region.

"People have been trying to extend the limits of air cooling for years and years," Fisher said.

Liquid cooling, on the other hand, would be expensive and prone to breakdown.

"Electronics manufacturers ultimately are most interested in reliability because so much of what we do now depends completely on the reliability of our systems," Fisher said. "This would have no moving parts, making it quiet and reliable."

Conventional fans use too much space and energy for laptop computers, which have to be cooled entirely with heat sinks and tube-like "heat pipes" that dissipate heat. For that reason, the ion-driven cooling device represents a way to increase cooling capacity in laptops, meaning they could use higher-performance chips that generate too much heat for current laptops, Garimella said.

Perhaps more than one of the devices could be placed on a single chip, multiplying the degree of cooling.

First, however, the researchers must establish how much cooling could be achieved with the technique. New experimental results quantifying the cooling performance may be reported this summer.

Most features of the device could be manufactured with conventional silicon fabrication techniques used in the semiconductor industry to make computer chips, Garimella said.

The research has been funded by the National Science Foundation, the Semiconductor Research Corporation and the Purdue Research Foundation.

Other Headlines from ***Purdue University*** *...*

- Self-Assembled 'Nanorings' Could Boost Computer Memory
- Purdue research suggests 'nanotubes' could make better brain probes
- 'Nano-Lightning' Could Be Harnessed to Cool Future Computers
- Nano-lightning To Create Tiny Wind Currents To Cool Future Computers

More ***Patent*** *Headlines ...*

- Nanogen Issued Nanotechnology Patent for Photonic Driven Assembly and Hybridization
- Patent License Agreement Concluded between Sumitomo & NEC Relating to Carbon Nanotube
- Altair Nanotechnologies Awarded Fourth U.S. Patent
- CombiMatrix's Partner Nanomaterials Discovery Corporation Issued Key Nanotech Patent
- Carbon Nanotechnologies Inc. Announces Issue of Key Patent

FEEDBACK

« **Leave Feedback** »

« **Back To List** »