

## Science News

Share Blog Cite

Print Bookmark Email

### 'Nano-Lightning' Could Be Harnessed To Cool Future Computers

ScienceDaily (Mar. 31, 2004) — WEST LAFAYETTE, Ind. — 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.

#### See Also:

#### Matter & Energy

- Thermodynamics
- Fuel Cells
- Microarrays

#### Computers & Math

- Computer Science
- Spintronics Research
- Mobile Computing

#### Reference

- Electrical conduction
- Electrical phenomena
- Nanowire
- Heat pump

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.

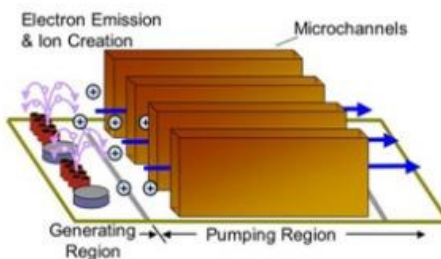
The ionized air molecules cause currents like those created by the "corona wind" phenomenon, which happens between electrodes at voltages higher than 10 kilovolts, or 10,000 volts.

"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

Microscale Ion Driven Air Flow



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. This diagram depicts one version of the design, including the carbon nanotube electrodes, represented by thin red tubes on the left, which emit electrons and make it possible to create the ionizing effects of lightning using low voltage. (Daniel J. Schlitz, Purdue School of Mechanical Engineering)

#### Ads by Google

#### Unsure Where to Invest?

See what Jim Cramer is trading for his Charitable Trust today. [www.TheStreet.com](http://www.TheStreet.com)

#### Patient Cooling Systems

Innovative & Non-invasive Methods Of Controlling body Temp. Call Now! [www.CSZMedical.com](http://www.CSZMedical.com)

#### Cool Savings from Sears

Save \$325 on a New Air Conditioner From Sears - Keep Cool All Year! [SearsHomeServices.com](http://SearsHomeServices.com)

#### Heating & Cooling Systems

Geothermal Heating & Cooling Costs Enter Zip & Get 3 Bids In Seconds! [RemodelRepairReplace.com/Geothermal](http://RemodelRepairReplace.com/Geothermal)

#### Related Stories



**New Technology Has Dramatic Chip-Cooling Potential For Future Computers** (Aug. 14, 2007) — Researchers have demonstrated

a new technology using tiny "ionic wind engines" that might dramatically improve computer chip cooling, possibly addressing a looming threat to future advances in ... > [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](#)



**New Material For Nanoscale Computer Chips** (Sep. 17, 2009) — New data from

#### Just In:

Scientists Steer Car With Power of Thought

#### Science Video News



#### Measuring Lightning

Electrical engineers developed a mathematical equation to measure the electrical current strength of lightning as it strikes tall buildings. The ... > [full story](#)

Atmospheric Scientists Link Lightning to Ice Particles In Clouds

Physicists, Engineers Capture Lightning with Tethered Rockets

Computer Engineers Develop Clothes that Sense and Interpret Movements

[more science videos](#)

#### On-site Computer Repair

Affordable Same Day Service Servicing Montgomery County, MD [www.1877geeksonsite.com](http://www.1877geeksonsite.com)

#### 2-Phase Liquid Cooling

Increased power density, decreased weight in a smaller footprint [www.parker.com/pc](http://www.parker.com/pc)

#### Precision Forged Heatsink

More efficient thermal transfer in a smaller space [www.cooliance.com](http://www.cooliance.com)

#### Thermic Earth

Geothermal heating and air conditioning [www.thermicearth.com](http://www.thermicearth.com)

Ads by Google

#### Breaking News

... from NewsDaily.com

CERN collider restarts search for cosmic mysteries



WSI sees mild weather for UK, cold for east Europe

WSI sees mild weather for UK, cold for east Europe

NASA readies for next week's space shuttle launch

Malaysia turn to science for golden breakthrough

[more science news](#)

#### In Other News ...

Credit Suisse banker arrested in U.S. - report

Gaddafi defiant in face of mounting revolt

New Zealand PM says quake kills at least 65

Housing data may

"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

 Chinese-Danish collaboration shows that organic nanoscale wires could be an alternative to silicon in computer ... > [read more](#)

### **How Do Thunderstorms Create Lightning? High-Energy Particles From Space Used To Probe Thunderstorms** (June 3, 2009) —

Scientists have developed a new technique to remotely measure thunderstorm electric fields on the ... > [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](#)

### **Don't Use Mobile Phone During Storms, Warn Doctors** (June 22, 2006) —

Three doctors in a recent British Medical Journal warn of the risk of using mobile phones outdoors during stormy ... > [read more](#)

### **Chemistry Research Could Produce Faster Computers** (July 11, 2006) —

Chemists at the University of Liverpool are helping to create future electronics based on molecules for faster and smaller ... > [read more](#)



### **Micro-Pump Is Cool Idea For Future Computer Chips** (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 ... > [read more](#)

Ads by Google

#### **Adiabatic Humidification**

Energy Efficient Humidification Sys  
Evaporative Cooling Systems  
[www.mistification.com](http://www.mistification.com)

#### **Cooling Data Centers**

Learn Data Center Best Practices,  
Tips & Hot Topics. Enroll Free Now!  
[APC.com/DataCenterUniversity](http://APC.com/DataCenterUniversity)

#### **Mupid Mini Gel Systems**

Mupid-exU, Mupid-2plus, Mupid-One  
DNA/RNA gel electrophoresis systems  
[www.helixtec.com](http://www.helixtec.com)

#### **New Parkinson's Research**

Discover an Exercise Bike Proven to  
Reduce PD Symptoms. Free DVD Today!  
[www.Theracycle.com](http://www.Theracycle.com)

have understated extend of collapse: report

Wal-Mart must prove executives right on recovery

Penalty fees down under card law, regulators say

Wisconsin governor asks Democrats to come home

Libya must stop bloodshed now, Clinton says

[more top news](#)

Ads by Google

#### **Alzheimer's Research**

Clinical Study for Alzheimer's Patients.  
Join Our Research.  
[www.GAPstudy.com](http://www.GAPstudy.com)

#### **Virtual Tissue Banking**

Biocator:  
Connecting researchers with biospecimens, on the web

#### **Suffering With Peyronie's**

Consider Joining A Research Study. Find A Physician Near You.  
[www.Peyronies-Research.com](http://www.Peyronies-Research.com)

#### **Heat Pump Estimates**

Find Local Contractors to Install a New Energy Efficient Heat Pump.  
[HeatPumps.Reply.com](http://HeatPumps.Reply.com)

#### **Coal Energy in Your State**

Fact -Coal accounts for almost half of the electricity in the US.  
[AmericasPower.org](http://AmericasPower.org)

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:

Send It

cooling capacity in laptops, meaning they could use higher-performance chips that generate too much heat for current laptops, Garimella said.

Number of stories in archives: 98,428

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.

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 (2004, March 31). 'Nano-Lightning' Could Be Harnessed To Cool Future Computers. *ScienceDaily*. Retrieved February 23, 2011, from <http://www.sciencedaily.com/releases/2004/03/040331004036.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.

---

Find with keyword(s):

Search

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.

[About ScienceDaily®](#) | [Editorial Staff](#) | [Awards & Reviews](#) | [Contribute News](#) | [Advertise With Us](#) | [Privacy Policy](#) | [Terms of Use](#)  
Copyright © 1995-2010 ScienceDaily LLC — All rights reserved — Contact: [editor@sciencedaily.com](mailto:editor@sciencedaily.com)  
*Note: This web site is not intended to provide medical advice, diagnosis or treatment.*

**Part of the iVillage Your Total Health Network**