



Ads by Google

[Electric Generators](#)

Hassle-Free Backup
Power By GE. 24/7
Backup Power For Your
Home!

www.HomeStandbyGeneratorSystem.com

[Twin Village Recycling Co](#)

Buyer Of All Scrap Iron &
Metal Buyer Of Junk
Vehicles.Free Towing.

www.tvrdepew.com

[Buying Heat Exchangers?](#)

Talk to our expert
engineers to get
specification help today

www.spec-eng.com

[Radiant Heat Estimates](#)

Repair & Install Pros
Available Now Get
Radiant Heat Estimates
Today!

www.ServiceMagic.com

[Heat Exchangers](#)

Standard Models &
Custom Designs. Use our
Online Calculator!

www.ExergyLLC.com

[Home](#) » [content](#)

UB engineers prove that carbon nanotubes are superior to metals for electronics

[Alfe Heat Treating](#)

Aluminum & Steel Heat Treating Experts. Certified, Fast
Turnaround

www.al-fe.com

[Elicarb™ SW](#)

Single-wall carbon nanotubes Commercial supplies

www.thomas-swan.co.uk

[Metals Testing Lab](#)

Metals Testing & Analysis for Steel and other metals, fast
turnaround

www.tksna.com

[3 Steps to Fix the Grid](#)

We need to build a modern energy grid now - find out how.

www.modernizethagrid.com

Ads by Google

[ShareThis](#)

BUFFALO, N.Y. -- In the quest to pack ever-smaller electronic devices more densely with integrated circuits, nanotechnology researchers keep running up against some unpleasant truths: higher current density induces electromigration and thermomigration, phenomena that damage metal conductors and produce heat, which leads to premature failure of devices.

But University at Buffalo researchers who study electronics packaging recently made a pleasant discovery: that's not the case with Single-Walled Carbon Nanotubes (SWCNTs).

"Years ago, everyone thought that the problem of cooling for electronics could be solved," said Cemal Basaran, Ph.D., professor in the UB Department of Civil, Structural and Environmental Engineering and director of the Electronics Packaging Lab in UB's School of Engineering and Applied Sciences. "Now we know that's not true. Electronics based on metals have hit a wall. We are done with metals."

Single Walled Carbon Nanotubes are extremely thin, hollow cylinders, measuring no thicker than a single atom. Thousands of times stronger than metals, they are expected to one day replace metals in millions of electronic applications.

Basaran and his doctoral student Tarek Ragab have spent the past four years performing quantum mechanics calculations, which prove that in carbon nanotubes, higher current density does not lead to electromigration and thermomigration; it also produces just one percent of the heat produced by traditional metals, such as copper.

Basaran will present the findings in November when he delivers a keynote lecture at the American Society of Mechanical Engineers (ASME) International Mechanical Engineering Congress and Exposition in Orlando.

The findings demonstrate yet another tantalizing property of CNTs, he said.

"It has been assumed that for carbon nanotubes, the electrical heating process would be governed by Joules law, where resistance in a circuit converts electric energy into heat," said Basaran. "We are the first to show mathematically, from a quantum mechanics point of view, that carbon nanotubes do not follow Joules law."

According to Basaran, this essential difference between metals and carbon nanotubes lies in the way they conduct electricity.

"Even though carbon nanotubes are conductive, they do not have metallic bonds," he said. "As a result,

No good options? Let's do better



"I've got to work until I'm 69 just to carry my wife on health insurance." - Dave, NC

**PRESCRIPTION
for CHANGE.org**

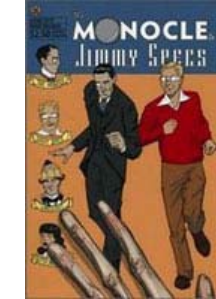
We all lose when a young man can't start his own business, a grandfather can't retire, a woman can't afford that cancer screening, or a family goes bankrupt to pay for a child's care. Having health insurance, that's controlling our lives right now.

It doesn't have to be that way.

Act now!

Read more...

The Monocle and Jimmy Specs



They should have been the greatest crime-fighting duo of all time...

"A quiet and deftly written/drawn story.... If you're feeling adventurous and open-minded, give this one a try." - *Ain't It Cool News*

"A terrific comic, one you should definitely pick up." - *Comixtreme.com*

Read more...

Advertise here

About us

Science Blog was started in August 2002. It lives, breathes and eats news releases from research organizations around the globe. Much of what you read here are releases from the outfits mentioned in the stories themselves. Got a news story you think belongs here? [Let's talk](#). The other half of the equation is [blog posts](#) from readers like you. So if you have an interest in science, [please register](#) and join others like you in an ongoing, vibrant dialog about what makes the world tick. Meantime, please take a minute to read our [Privacy Policy and Site Disclaimer](#).

evated train.

"In the conventional train, you have friction between the wheels and the track," said Basaran. "Through the generation of heat, that friction causes a loss of energy. But with a magnetically levitated train, the wheels and track are not in direct contact. Without that friction, they can travel much faster."

The minimal amount of friction gives carbon nanotubes a tremendous advantage over conventional metals, said Basaran. The unique properties of carbon nanotubes will allow engineers to realize a host of smaller, faster and more powerful new devices that right now cannot exist because of the limitations of conventional metals.

"When an electric car finally is manufactured, its batteries probably will be based on carbon nanotubes," said Basaran. "You can't use traditional metals in the engines because they run so hot."

Much of Basaran's \$1 million-plus funding at UB comes from sources like the U.S. Navy, which is interested in sophisticated electronics systems that could operate under very demanding conditions, such as the electric ship the Navy is building.

Basaran's unique perspective comes from decades of research, which has fundamentally changed what is known about the high current density performance properties of metals and their limitations.

He also sounded a cautionary note, pointing out that current research and development expenditures on carbon nanotubes in the U.S. electronics industry are very small when compared to those of our Asian competitors.

"If the industry continues this way, when carbon nanotube-based electronics become a reality, U.S. electronics manufacturers may be in a position similar to U.S. car manufacturers today, because they have failed to keep up with advances in engineering," he said.

[Precious Metals Stocks](#)

2009 Hottest Precious Metals Stocks 3
Precious Metals Picks- Free Report
www.FreeInvestingReports.com/metal

[Carbon nanotubes](#)

Field emission grade CNT powder. High emission current.
www.xintek.com/products

[Buy Carbon Nanotubes](#)

High Quality CNTs At Low Prices. CVD CNTs. Check Out Our Pricelist!
www.CheapTubes.com

Ads by Google

[American Society](#) [Buffalo](#) [Cemal Basaran](#) [Congress](#) [director](#) [electricity](#) [electronics](#) [energy](#) [environmental engineering](#) [integrated circuits](#) [metal](#) [New York](#) [Orlando](#) [professor](#) [Tarek Ragab](#) [Technology](#)

[Permalink](#)

March 20, 2009

Comments

[reasons for why joule law doesn't apply](#)


March 23, 2009 by *Anonymous*, 8 weeks 2 days ago
Comment id: 35531

Science Jobs

[Senior Scientist](#)
[Research Assistant III](#)
[Clinical Psychologist Job \(T...](#)
[Assistant Research Scientist](#)
[Coordinator of Research P...](#)
[Chemist](#)
[Clinical Research Coordinator](#)
[Visiting Research Specialist](#)
[Virologist 2](#)

[More Jobs](#)

Employers & Recruiters

 Post your job for FREE across hundreds of sites

[Find out more](#)

Powered by [realmatch](#)

Joule law define the heat as I^2R . So it takes the collective resistance of the material, regardless of the mechanisms of scatterings, but in CNTs due to there unique energy dispersion relations, a large portion of the resistance is due to scatterings involving momentum exchange rather than energy exchange that cause the joule heating. That's why joule law doesn't apply to nanostuctures like CNTs.

[reply](#)

Joules Law

March 23, 2009 by *Anonymous*, 8 weeks 3 days ago
Comment id: 35529

Joule law is for metallic bond materials, where atoms are bonded to each other with a sea of electron. CNT is a covalent bond material. So it is natural that Joule law does not apply, because concept of resistance is based on metallic bond. Both quantum mechaincs calculations and experimental data show that in ballistic conduction Joule Law does not work. It is like trying to use solid mechanics equations to fluid mechanics. They are different animals.

[reply](#)

What????

March 20, 2009 by *Anonymous*, 8 weeks 5 days ago
Comment id: 35482

Quote from article.

"It has been assumed that for carbon nanotubes, the electrical heating process would be governed by Joules law, where resistance in a circuit converts electric energy into heat," said Basaran. "We are the first to show mathematically, from a quantum mechanics point of view, that carbon nanotubes do not follow Joules law."

This statement appears to be meaningless.

Joules law #1,

States that the heat produced is proportional to the current squared * resistance.

Just because the resistance to current flow is lower in a carbon nanotube than a metal such as copper doesn't mean that Joules law isn't followed.

Joules law #2, which doesn't seem to apply here, says that the internal energy of an ideal gas is independent of its pressure and volume.

[reply](#)

Post new comment

Subject:

Comment: *

■ Allowed HTML tags: <cite> <code> <dl> <dt> <dd><p>

<blockquote>

- Lines and paragraphs break automatically.

[More information about formatting options](#)



Preview

Recommended

[Andrew Sullivan](#) [Dan Sullivan](#) [Doug Arellanes](#) [Emmanuelle Richard](#) [Faith Sullivan](#)
[Fred Bortz](#) [Heather Havrilesky](#) [Henry Copeland](#) [Kate Sullivan](#) [Ken Layne](#)
[lagreenbean.com](#) [LAist.com](#) [Maggie Sullivan](#) [Matt Welch](#) [NewYorkology](#) [Opinion L.A.](#)
[Ron Kaye](#) [Slashdot](#) [Sploid](#) [Steve Elzer & Family](#) [Thor Garcia](#) [Tony Pierce](#) [Wonkette](#)
[Older](#)

Thanks CNET for naming Science Blog one of your Blog 100!

Copyright, Science Blog.

Think. It's not illegal yet. Read our [Privacy Policy](#).