Sep/Oct 2011 • No. 209

ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

Dear ESA Colleagues,

As I begin my term as President of the ESA, I have been thinking about how the ESA should move forward. What are the goals of our Society, and how should we adjust what we do in order to better achieve these goals?

For me, the principal mission of the ESA is to be the primary forum for research, applications and pedagogy related to electrostatics phenomena. The ESA Annual Meetings should be the venue where leading investigators from around the world come together to disseminate, discuss and debate the cutting-edge developments in this area.

What can we do to maintain and expand ESA's role as such? I believe one way is to have focused sessions at the ESA meeting devoted to a specific topic of current interest and importance. These sessions could include approximately 10 talks. In developing these sessions, there could be a snowball effect – once a 'critical mass' of eminent participants is on board, others will be attracted to join in. The critical mass could be established by inviting leaders in the field from outside the ESA, to add to the contributions from ESA members.

We used this approach in the 2011 Annual Meeting, held in June at Case Western Reserve University. The focus sessions addressed the fundamental basis of triboelectric charging – this topic has, of course, been an area of strong interest in the ESA, with many of our members making important contributions. A number of researchers who do leading work in the field, but who had never previously attended an ESA meeting, came to the 2011 Annual Meeting: Fernando Galembeck (Univ. of Campinas, Brazil), Chongyang Liu (Univ. of Texas), Troy Shinbrot and Ben Glasser (Rutgers Univ.), Bilge Baytekin and Tarik Baytekin (Northwestern Univ.), Sam Thomas (Tufts Univ.), Meir Lahav and Silvia Piperno (Weizmann Inst., Israel), Scott Waitukaitis (University of Chicago) and Indrani Bhattacharyya (Indiana University).

I believe we should continue this approach. Along these lines, Tom Jones (Univ. of Rochester) is organizing a focus session for the 2012 ESA Meeting, addressing exciting demonstrations of electrostatic phenomena.

I invite more of our members to become involved in this approach. Do you have ideas in mind for focus sessions, which would be both of interest to our members and could attract leaders in the field from outside the ESA? Could this focus session bring together a core group of scientists or engineers working on a topic that does not otherwise have a clear home? Please contact me if you have some ideas for topics that would generate excitement and interest.

More generally, please let me know if you have thoughts on how to make the ESA better.

Dan Lacks,
President, ESA
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ESA Officers

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Vice President
Shesha Jayaram, Univ. of Waterloo
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Sheryl Barringer, Ohio State Univ.
Kelly Robinson, Electrostatic Answers, LLC
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ESA 2012: Electrostatic Demonstrations Workshop

At the upcoming joint ESA/IEJ/IAS/SFE Meeting set for June 14-16, 2012, in Waterloo, Ontario, Canada, plans are afoot for a special half-day workshop devoted to electrostatics demonstrations. Though the format is yet to be decided upon, the goal will be to assemble electrostatics experts from around the world and representing the diverse field of safety training, consulting, and education to present their favorite demonstrations. After each short presentation, there will be time scheduled to discuss the demonstration, focusing on the principles and practical lessons it conveys. The last part of the session will be an open discussion intended to engage all attendees in development of some strategies for promoting electrostatics demonstrations as a way to re-instill fun and enthusiasm in science learning at all levels. An effort will be made to schedule a special evening presentation for area high school science teachers looking for ways to excite their students with new enthusiasm for electrostatics.

If you have a favorite demonstration to share or have an idea for a new one, this is the event for you. Please direct questions and suggestions for this session to me. I am open to your ideas.

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Calendar

- 2nd ISNPEDADMSA (New electrical tech. for environment), Nov. 14-19, 2011, Noumea, New Caledonia, Contact: Gerard Touchard, *gerard.touchard@univ-poitiers.fr,* website: http://lea.sp2mi.univ-poitiers.fr/noumeameeting/
- ESA-2012, Joint ESA/IEJ/IAS/SFE Meeting, June 12-14, 2012, Univ. of Waterloo, Waterloo, Ontario, Canada, Contact: Shesha Jayaram, *jayaram@uwaterloo.ca,* website: http://www.electrostatics.org
- ICAES-2012, 7th Int'l. Conf. on Applied Electrostatics, Sept. 17-19, 2012, Dalian Univ. of Tech., Dalian, China, Contact: Secretariat Office, Ph: +86 411 84708576-604, *ICAES2012@163.com,* website: http://www.icaes-2012.org/windows/index.htm (abstracts due Apr. 30, 2012)

ICAES-12

7th International Conference on Applied Electrostatics
September 17-19, 2012, Dalian, China

The ICAES is hosted by the Electrostatics Committee of Chinese Society of Physics, and held every four years. This year, the ICAES-2012 is organized by Dalian University of Technology in Dalian. The conference is intended to provide an open forum to report on topics of Electrostatic Fundamentals, Electrostatic Application, Safety and Hazards of Electrostatics, ESD and EMC, Measurements, and Atmosphere Pressure Plasma, etc. More information on ICAES-2012 will be available on the conference website at *http://www.ICAES-2012.org*.

2012 ELECTROSTATICS JOINT CONFERENCE

June 12-14, 2012

HOLIDAY INN CAMBRIDGE HESPELER GALT

Cambridge, Ontario, Canada

INTERNATIONAL ELECTROSTATIC ASSEMBLY (IEA)

Institute of Electrostatics Japan	Electrostatics Society of America	International Electrostatics Assembly	IEEE-IAS Electrostatic Processes Committee	Societe Francaise d'Electrostatique

The scope of the conference ranges from the fundamental physics underlying electrostatics to applications in industry, atmospheric and space sciences, medicine, energy, and other fields.

Technical sessions

- Atmospheric and space applications
- Biological and medical applications
- Breakdown and discharge
- Electrostatic forces and fields
- Electrostatics in flowing liquids
- Materials behavior and processing
- Measurement and instrumentation
- Particle control and charging
- Safety and hazards

For more information, see
http://www.electrostatics.org/conferences.html

Deadline for abstracts: March 1, 2012.
Submit abstracts online at conference website.

General Chair: Shesha Jayaram
jayaram@uwaterloo.ca

Technical Committee Chair: Noras, Maciej
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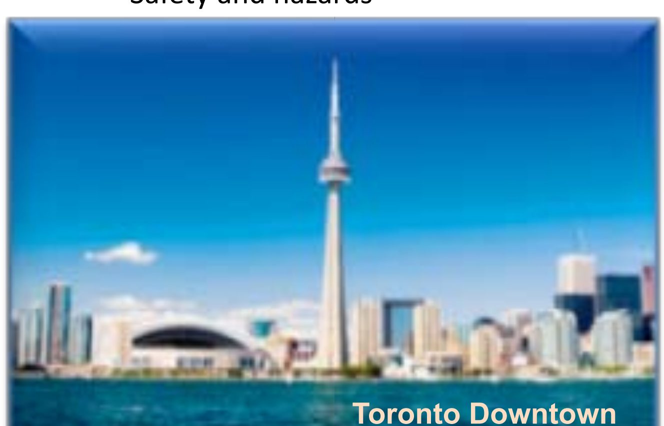


Current Events

Thunderstorms Hurling Antimatter into Space

Scientists using NASA's Fermi Gamma-ray Space Telescope have detected beams of antimatter produced above thunderstorms on Earth, a phenomenon never seen before. Scientists think the antimatter particles were formed in a terrestrial gamma-ray flash (TGF), a brief burst produced inside thunderstorms and shown to be associated with lightning. It is estimated that about 500 TGFs occur daily worldwide, but most go undetected.

"These signals are the first direct evidence that thunderstorms make antimatter particle beams," said Michael Briggs, a member of Fermi's Gamma-ray Burst Monitor (GBM) team at the University of Alabama in Huntsville (UAH). He presented the findings during a news briefing at the American Astronomical Society meeting in Seattle.

Fermi is designed to monitor gamma rays, the highest energy form of light. When antimatter striking Fermi collides with a particle of normal matter, both particles immediately are annihilated and transformed into gamma rays. The GBM has detected gamma rays with energies of 511,000 electron volts, a signal indicating an electron has met its antimatter counterpart, a positron.

Although Fermi's GBM is designed to observe high-energy events in the universe, it's also providing valuable insights into this strange phenomenon. The GBM constantly monitors the entire celestial sky above and the Earth below. The GBM team has identified 130 TGFs since Fermi's launch in 2008.

The spacecraft was located immediately above a thunderstorm for most of the observed TGFs, but in four cases, storms were far from Fermi. In addition, lightning-generated radio signals detected by a global monitoring network indicated the only lightning at the time was hundreds or more miles away. During one TGF, which occurred on December 14, 2009, Fermi was located over Egypt. But the active storm was in Zambia, some 2,800 miles to the south. The distant storm was below Fermi's horizon, so any gamma rays it produced could not have been detected.

"Even though Fermi couldn't see the storm, the spacecraft nevertheless was magnetically connected to it," said Joseph Dwyer at the Florida Institute of Technology in Melbourne, FL. "The TGF produced high-speed electrons and positrons, which then rode up Earth's magnetic field to strike the spacecraft." The beam continued past Fermi, reached a location, known as a mirror point, where its motion was reversed, and then hit the spacecraft a second time just 23 milliseconds later. Each time, positrons in the beam collided with electrons in the spacecraft. The particles annihilated each other, emitting gamma rays detected by Fermi's GBM.

Scientists long have suspected TGFs arise from the strong electric fields near the tops of thunderstorms. Under the right conditions, they say, the field becomes strong enough that it drives an upward avalanche of electrons. Reaching speeds nearly as fast as light, the high-energy electrons give off gamma rays when they're deflected by air molecules. Normally, these gamma rays are detected as a TGF.

But the cascading electrons produce so many gamma rays that they blast electrons and positrons clear out of the atmosphere. This happens when the gamma-ray energy transforms into a pair of particles: an electron and a positron. It's these particles that reach Fermi's orbit.

The detection of positrons shows many high-energy particles are being ejected from the atmosphere. In fact, scientists now think that all TGFs emit electron/positron beams. A paper on the findings has been accepted for publication in Geophysical Research Letters.

(excerpted from *http://www.scientificcomputing.com/news-DS-Thunderstorms-Hurling-Antimatter-into-Space-011311.aspx?et_cid=973167&et_rid=41420904&linkid=http%3a%2f%2fwww.scientificcomputing.com%2fnews-DS-Thunderstorms-Hurling-Antimatter-into-Space-011311.aspx*)

Creasing to cratering: Voltage breaks down plastic

A Duke University team has seen for the first time how soft polymers, such as wire insulation, can break down under exposure to electrical current. Researchers have known for decades that polymers, such those insulating wires, may break down due to deformation of the polymers. But the process had never been seen.

In a series of experiments, Duke University engineers have documented at the microscopic level how plastic deforms to breakdown as it is subjected to ever-increasing electric voltage. Polymers can be found almost everywhere, most commonly as an insulator for electrical wires, cables and capacitors. The findings by the Duke engineers could help in developing new materials to improve the durability and efficiency of any polymer that must come into contact with electrical currents, as well as in the emerging field of energy harvesting.

"We have long known that these polymers will eventually break down, or fail, when subjected to an increasing electrical voltage," said Xuanhe Zhao, assistant professor of mechanical engineering and materials science at Duke's Pratt School of Engineering. He is the senior scientist in the series of experiments performed by a graduate student Qiming Wang and published online in the Physical Review Letters. "Now we can actually watch the process as it happens in real time."

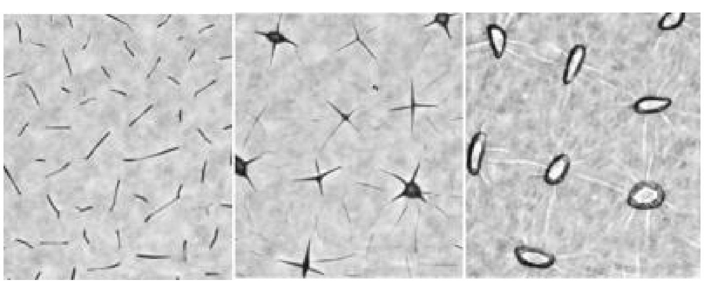
The innovation the Duke team developed was attaching the soft polymer to another rigid polymer layer, or protective substrate, which enabled observation of the deformation process without incurring the breakdown. They then subjected this polymer-substrate unit to various electrical voltages and observed the effects under a microscope.

"As bread dough rises in a bowl, the top surface of the dough may fold in upon itself to form creases due to compressive stresses developing in the dough," Zhao said, "Surprisingly, this phenomenon may be related to failures of electrical polymers that are widely used in energy-related applications."

"When the voltage reached a critical point, the compressive stress induced a pattern of creases, or folds, on the polymer," Zhao. "If the voltage is increased further, the creases evolved into craters or divots in the polymer as the electrical stress pulls the creases open. Polymers usually break down electrically immediately after the creasing, which can cause failures of insulating cables and organic capacitors."

The substrate the researchers developed for the experiments not only allowed for the visualization of the creasing-to-cratering phenomenon, it could also be the foundation of a new approach to improving the ability of wires to carry electricity.

(from *http://www.eurekalert.org/pub_releases/2011-03/du-ctc030311.php*)



Taming the Flame: Electrical Wave Blasters could Control Fires

A curtain of flame halts firefighters trying to rescue a family inside a burning home. One firefighter with a special portable flame-tamer device steps to the front, points a wand at the flame, and shoots a beam of electricity that opens a path through the flame for the others to pass and lead the family to safety.

A discovery could underpin a new genre of fire-fighting devices, including sprinkler systems that suppress fires not with water, but with zaps of electric current, without soaking and irreparably damaging the contents of a home, business or other structure. Reporting on March 27, 2011, at the 241st National Meeting & Exposition of the American Chemical Society (ACS), Ludovico Cademartiri, Ph.D., and his colleagues in the group of George M. Whitesides, Ph.D., at Harvard University, picked up on a 200-year-old observation that electricity can affect the shape of flames, making flames bend, twist, turn, flicker, and even snuffing them out. However, precious little research had been done over the years on the phenomenon.

“Controlling fires is an enormously difficult challenge,” said Cademartiri, who reported on the research. “Our research has shown that, by applying large electric fields, we can suppress flames very rapidly. We’re very excited about the results of this relatively unexplored area of research.”

Firefighters currently use water, foam, powder and other substances to extinguish flames. The new technology could allow them to put out fires remotely — without delivering material to the flame — and suppress fires from a distance. The technology also could save water and avoid the use of fire-fighting materials that could potentially harm the environment, the scientists suggest.

In the new study, they connected a powerful electrical amplifier to a wand-like probe and used the device to shoot beams of electricity at an open flame more than a foot high. Almost instantly, the flame was snuffed out. Much to their fascination, it worked time and again.

The device consisted of a 600-watt amplifier, or about the same power as a high-end car stereo system. However, Cademartiri believes that a power source with only a tenth of this wattage could have similar flame-suppressing effect. That could be a boon to firefighters, since it would enable use of portable flame-tamer devices, which perhaps could be hand-carried or fit into a backpack.

But how does it work? Cademartiri acknowledged that the phenomenon is complex, with several effects occurring simultaneously. Among these effects, it appears that carbon particles, or soot, generated in the flame are key for its response to electric fields. Soot particles can easily become charged. The charged particles respond to the electric field, affecting the stability of flames, he said.

“Combustion is first and foremost a chemical reaction — arguably one of the most important – but it’s been somewhat neglected by most of the chemical community,” said

Cademartiri. "We're trying to get a more complete picture of this very complex interaction."

Cademartiri envisions that futuristic electrical devices based on the phenomenon could be fixed on the ceilings of buildings or ships, similar to stationary water sprinklers now in use. Alternatively, firefighters might carry the flame-tamer in the form of a backpack and distribute the electricity to fires using a handheld wand. Such a device could be used, for instance, to make a path for firefighters to enter a fire or create an escape path for people to exit, he said.

The system shows particular promise for fighting fires in enclosed quarters, such as armored trucks, planes and submarines. Large forest fires, which spread over much larger areas, are not as suitable for the technique, he noted.

Cademartiri also reported how he and his colleagues found that electrical waves can control the heat and distribution of flames. As a result, the technology could potentially improve the efficiency of a wide variety of technologies that involve controlled combustion, including automobile engines, power plants, and welding and cutting torches, he said.

(from *http://www.scientificcomputing.com/news-DS-Taming-the-Flame-Electrical-Wave-Blasters-could-Control-Fires-040111.aspx?et_cid=1364788&et_rid=41420904&linkid=http%3a%2f%2fwww.scientificcomputing.com%2fnews-DS-Taming-the-Flame-Electrical-Wave-Blasters-could-Control-Fires-040111.aspx*)

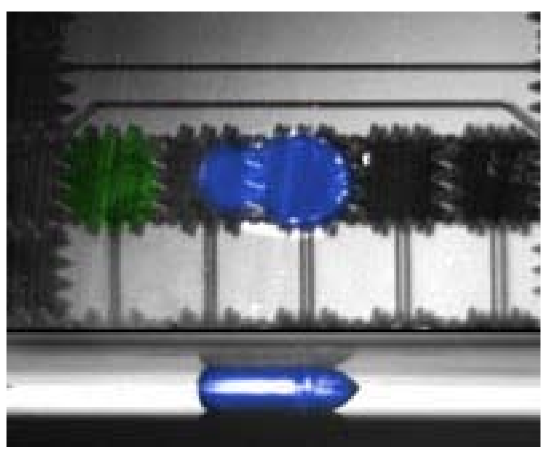
Walking Microdroplets Collect Viruses and Bacteria

The future of chemistry comes in the form of miniaturized devices designed to carry out reactions and chemical analyses. The fabrication of such systems, popularly called "labs on chip," is seriously challenging the engineers. "You can make an excellent microfabricated analytical system, but to make it work you still have to prepare the sample in a proper way," said Martin Jönsson-Niedziółka from the Institute of Physical Chemistry of the Polish Academy of Sciences (IPC PAS), adding, "Assume we have viruses and bacteria on a surface. Would we try to simply wash the surface with water, and then introduce a droplet of that water into a microanalyzer, the result would be poor. Just because the concentration of the pollutants will be too low."

To ensure the highest possible concentration of bioparticles, it is better to use a small water droplet, just a microliter in volume. Such a droplet is introduced between two plates: a lower one with pollutant particles earlier deposited electrostatically, and a top one, coated with a system of small electrodes and an insulating layer (protecting against current flow through the droplet, which could lead to electrolysis). By making use of a phenomenon called electrowetting and applying voltage in a proper way, the droplet can be precisely displaced over the surface and so collect bioparticles from the entire plate. An additional advantage of the method is that the sample collected is already in the liquid state as required by many measurement methods. Moreover, as the displacement of the microdroplet is easy to control, the problem of how to deliver the sample to further lab-on-chip components disappears.

The systems with microdroplets have been fabricated and tested for a couple of years. A group of researchers, from the Institute of Physical Chemistry of the PAS led by Martin Jönsson-Niedziółka, the French Institut d'Electronique, de Microélectronique et de Nanotechnologie led by Vincent Thomy and the Institut de Recherche Interdisciplinaire led by Rabah Boukherroub, had doubts about the fact that all earlier reports on microdroplets described the collection of latex microspheres from the surface. These particles are used because they are easily available in various sizes and safe in tests. It was not clear if the microdroplets would equally efficiently collect real bioparticles, such as bacterial spores or viruses.

The study made use of a microdevice fabricated by the French group. The particles investigated in tests included inactive bacteriophage MS2 (virus that infects bacteria), Bacillus atrophaeus spores and OA (ovalbumin) proteins. The bioparticles were deposited on two different surfaces. One of them was a hydrophobic surface, coated with a substance that resembles Teflon. The other plate was fab-



Microdroplet (blue) displacement on a superhydrophobic surface stimulated by 60V voltage, top and side views. The area of each electrode (green) was 2 mm2. Artificial colors.

ricated using nanowires (1 micrometer long) and its hydrophobicity was close to that characteristic for the famous lotus leaves. Until now, such superhydrophobic surfaces were not studied in any microdevices making use of electrowetting.

In experiments with viruses, the type of surface they were deposited on did not have any significant effect on the microdroplet cleaning efficiency. The cleaning efficiency was 98-99% and was higher than that typical for latex particles (92-93%). Different results have been found, however, for spores and protein molecules. High cleaning efficiency was found here for superhydrophobic surface only (99 and 92%, respectively), whereas the corresponding figures for hydrophobic surface were distinctly lower (46% and 71%, respectively).

The findings published in the prestigious journal Lab on a Chip demonstrate that the surface cleaning efficiency using microdroplets strongly depends on both the type of collected particles and the hydrophobic properties of the surface. "Everyone who wants to collect efficiently various bioparticles using microdroplets should use superhydrophobic surfaces," summed up Jönsson-Niedziółka.

(from *http://www.scientificcomputing.com/news-IN-Walking-Microdroplets-Collect-Viruses-and-Bacteria-060911.aspx?et_cid=1659049&et_rid=41420904&linkid=http%3a%2f%2fwww.scientificcomputing.com%2fnews-IN-Walking-Microdroplets-Collect-Viruses-and-Bacteria-060911.aspx*)

Researchers Find Way To Align Gold Nanorods On A Large Scale

Researchers from North Carolina State University have developed a simple, scalable way to align gold nanorods, particles with optical properties that could be used for emerging biomedical imaging technologies. Aligning gold nanorods is important because they respond to light differently, depending on the direction in which the nanorods are pointed. To control the optical response of the nanorods, researchers want to ensure that all of the nanorods are aligned.

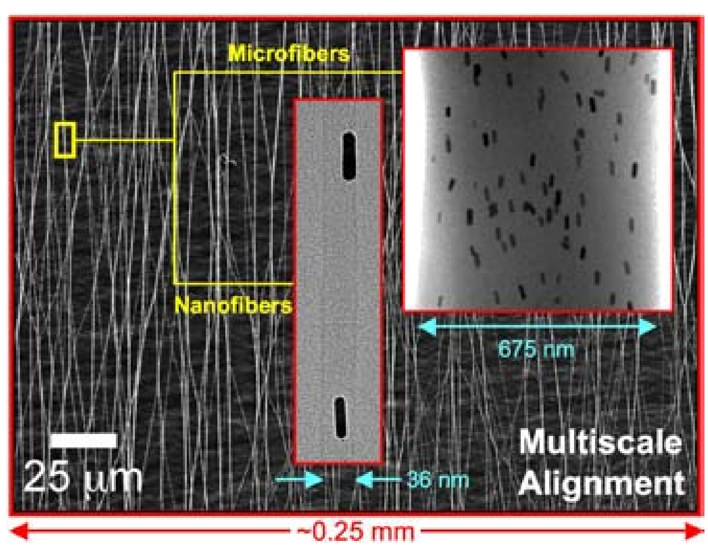
The NC State researchers developed a way to align the gold nanorods using electrospun polymer "nano/microfibers." Electrospinning is a way of producing fibers, with a liquid polymer being discharged from a needle and then solidifying. The researchers produced fibers as thin as 40 nanometers (nm) in diameter and as thick as three microns in diameter – thus, nano/microfibers. The researchers mixed the gold nanorods into the polymer solution, causing them to be incorporated directly into the polymer. The nanorods align when the fibers form. The force experienced by the liquid polymer as it is emitted from the electrospinning needle creates "streamlines" in the polymer solution.

"The nanorods are forced into alignment with these streamlines, like logs in a river that swing into alignment with the current," says Dr. Joe Tracy, an assistant professor of materials science and engineering at NC State and co-author of a paper describing the study. "And as the polymer solidifies, the aligned nanorods are locked into place."

"Electrospinning efforts at NC State are world-class and have yielded a wide range of novel and functional materials," adds Dr. Rich Spontak, a professor of chemical and biomolecular engineering and materials science and engineering at NC State and paper co-author. "What makes this result truly exciting is that the alignment is multiscale, or simultaneously achieved at different length scales. The nanorods are aligned at nanoscale dimensions, whereas the fibers are aligned at larger length scales."

This approach has been used in the past to align other kinds of nanorods, but this is the first time it has been done with gold nanorods. "To the best of our knowledge, this is also the first time nanorods of this size have been aligned in electrospun fibers," Tracy says, referring to the fact that the study focused on relatively short nanorods. Specifically, the researchers used nanorods with an aspect ratio of 3.1. For example, that means that a nanorod measuring 10 nm wide would be 31 nm long. The nanorods in the study were approximately 49 nm long. This aspect ratio is important, because it affects the way the nanorods interact with light – and, therefore, their optical properties.

(from *http://news.ncsu.edu/releases/wmstracygoldnanorods/*)



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