

## At PPPL THIS WEEK

### ALL WEEK

**Lab-wide office cleanup**

**TUESDAY, APR 14**

**Lehman Review**

8 a.m. to 2 p.m.

**WEDNESDAY, APR. 15**

**Colloquium**

2 p.m. ♦ MBG Auditorium

[A Wild Solution for  
Climate Change](#)

Professor Thomas E. Lovejoy,  
George Mason University

**FRIDAY, APR. 17**

**Open Public Tour**

10 a.m. ♦ LSB Lobby

Email [jjackson@pppl.gov](mailto:jjackson@pppl.gov)  
to register

### UPCOMING

**TUESDAY, APR. 21**

**Grounds Cleanup**

10:30 a.m.

**Lunch for volunteers**

April 23 rain date

**WEDNESDAY, APR. 22**

**Earth Day Celebration at PPPL**

Exhibits, Earth Day video, and  
special Earth Day colloquium

[See page 5 for schedule.](#)

**THURSDAY, APR. 23**

**Laboratory Management Meeting**

**SATURDAY, APR. 25**

**TEDxCarnegie event on "Revival"**

12 p.m. to 4 p.m. ♦ 65 Witherspoon  
Street, Princeton

**Andrew Zwicker will discuss  
"Reviving Science Education"**

**SUNDAY, APR. 26**

**Communiversy**

12 p.m. to 4 p.m. ♦ Princeton  
University/Princeton

**Volunteers Needed. See page 6 for  
more information.**

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## Synthetic muscle developed with PPPL scientists' help ready for launch

By Jeanne Jackson DeVoe

Lenore Rasmussen's dream of developing a synthetic muscle that could be used to make better prosthetic limbs and more responsive robots will literally become airborne on Monday, April 13, at 4:33 p.m. when her experiment will rocket off to the International Space Station.

Rasmussen developed the material at RAS Labs and has worked closely with researchers and engineers at the U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL) to develop the material's ability to adhere to metal. The Synthetic Muscle™ could be used in robotics in deep space travel such as travel to Mars because of its radiation resistance.

"Based on the good results we had on planet Earth, the next step is to see how it behaves in a space environment," said Charles Gentile, an engineer at PPPL who has worked closely with Rasmussen. "From there the next step might be to use it on a mission to Mars."

### Early connection with PPPL

Rasmussen began working with PPPL in 2007 just four years after she started Ras Labs. She received her first patent for a synthetic muscle in 1998. It is a gel-like material called an electroactive polymer that can potentially mimic human movement because it can expand and contract to simulate the movement of muscles in humans. That ability would make it very useful in robotics and in developing better prosthetic limbs.



Lenore Rasmussen treats the titanium coupon that holds the gel-like synthetic muscle with an oxygen plasma.

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# Synthetic limbs: Rasmussen's lifelong quest

Lenore Rasmussen's lifelong quest to develop a material that can be used in prosthetics began when she was growing up on a farm in West Virginia. Many people are injured, often fatally, in farm accidents, and Rasmussen's cousin nearly lost his leg working on the farm when Rasmussen was in graduate school. That experience fueled her ambition to develop better prosthetics and she has devoted her life to doing just that.

Rasmussen was further spurred on in her quest to develop the material when she and her family attended the 2013 Boston Marathon. Along with her husband and children, she watched the elite runners win. When her 10-year-old son reported being hungry and tired, they left the finish-line observing area. The bombing occurred at that spot 22 minutes later. Seeing the many people who lost limbs during the attack, including children, made Rasmussen more determined than ever to develop advanced prosthetic limbs employing her synthetic muscle technology.

Rasmussen is a synthetic polymer chemist, who founded RAS Labs in 2003. She began working with PPPL in the early stages of the company from 2007 through 2011. Rasmussen moved to Massachusetts in 2011 and the company is now headquartered in Quincy. In 2013, she won a highly competitive grant from the Center for the Advancement of Science in Space (CASIS) to pursue the synthetic muscle experiment on the International Space Station National Laboratory (ISS-NL) through the MassChallenge global business accelerator.

She plans to attend the payload launch at the Cape Canaveral Air Force Station Kennedy Space Center with her 12-year-old son Carl and her mother, Winola Carman. Carman lives on the family farm in Pennsboro, West Virginia, where five generations of Rasmussen's family have lived. Rasmussen said she wanted her mother to be there because of her years

of support, including putting her and her brothers through college. Carman did so by working nights as a nurse.

For Rasmussen, the launch is the culmination of her dreams. "It just blows my mind that humans are able to do this. It's pretty cool," said Rasmussen. "I'm a huge space junkie. I wish I were going with my samples!"

Rasmussen holds a PhD in chemistry, with a specialty in polymer chemistry from Virginia Tech and a master's degree in biology, with a specialty in biophysics from Purdue University. She worked at Johnson & Johnson in the 1990s, and lived in Hillsborough, New Jersey, until 2011. She is the editor of the book "Electroactivity in Polymeric Materials," and wrote a chapter on the theory of contraction (Springer-Verlag © 2012), and has another book on electroactivity in progress.

Rasmussen has also worked with numerous interns pursuing careers in science and engineering through PPPL's college internship program. "She's smart, she's energetic, and she's an inspiration for young scientists, particularly young women," said Lew Meixler, who headed the Department of Technology Transfer at PPPL until his recent retirement. 📍



Lenore Rasmussen works in a laboratory at PPPL.



Lenore Rasmussen and her summer interns examine a sample.

# Synthetic Muscle

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A photo of the titanium coupon being treated in the oxygen plasma.

“We can’t explore space without robots,” Rasmussen said. “Humans can only withstand a certain amount of radiation so that limits the time that people can be in space, whereas robots, particularly if they’re radiation-resistant, can be up there for long periods of time without being replaced.”

Lew Meixler, the long-time head of Technology Transfer at PPPL who retired in March, said he has enjoyed helping Rasmussen follow her quest. “That’s what entrepreneurs are,” he said. “They’re the dreamers who devote all their time, energy and resources to following their dreams.”



Engineer Charlie Gentile, in white, talking with Rasmussen, in black, who was involved in testing at PPPL and in planning for the space mission.

At PPPL, Rasmussen solved a crucial problem: getting the gel, which can be as soft as jelly or as hard as rubber, to adhere to the metal electrodes. Initially working with Meixler on a federal Cooperative Research and Development Agreement in the Plasma Surface Laboratory, she solved the problem by treating the metal (steel or titanium) with a plasma. This changed the metal’s surface and made the gel adhere more closely to the metal.

Rasmussen credits PPPL with providing help and support during critical points in her project. “It was and continues to be a wonderful resource not just because of the plasma physics but the people,” she said. “Charlie and Lew found ways to make things happen.”

PPPL was also involved with crucial tests of the material last summer, when the material was exposed to over 300,000

RADs of gamma radiation. That is 20 times the amount that would be lethal to a human and was equivalent to a trip from Earth to Mars and back. A second test of 45 hours was enough to be equivalent to a trip to Jupiter and beyond

Rasmussen and Gentile found that there was no change in the strength, electroactivity, or durability of the material due to the radiation, although there was a slight change in color. Tests on selected samples of the material found it was not affected by extreme temperatures down to -271 degrees Celsius, which is close to absolute zero, the coldest temperature possible in the universe.

## Preparing for launch

Since then, PPPL staff members have been involved in planning for the launch. This involves mapping out each detail with military precision. Several PPPL staff members, along with Rasmussen and her staff, signed the back of the metal container or coupon holding the material. “All of the people who worked on the lab signed it and the coupon will go into space,” said Gentile. “So I’ll be up there with Gene Roddenberry.”

The Synthetic Muscle™ material will be launched on the Falcon 9, a rocket carrying the Dragon spacecraft, both produced by Space X, which will carry 4,300 pounds of supplies



A photo of the synthetic muscle material before it was packed for transport to the International Space Station (Photo courtesy of NASA)

[continued on next page](#)

## Synthetic Muscle

and payloads, including material for research experiments, to the International Space Station's U.S. National Laboratory. The nine-engine rocket will propel the Dragon into orbit where it will meet with the Space Station 33 hours after the rocket is launched. Astronauts will use the station's 57-foot arm to reach out and capture Dragon at 7:15 a.m. on April 15. [Additional information about the launch is available on the NASA blog.](#)

The material will be kept in a zero-gravity storage rack in the U.S. National Laboratory on the space station for 90 days. The astronauts will photograph the materials every three weeks. When the material returns to Earth in July, it will be tested and compared with identical materials that remained on Earth.

The International Space Station is an international science laboratory in low Earth orbit where astronauts conduct scientific research in biology, human biology, astronomy, meteorology and other fields in a gravity-free environment. It has operated since November of 2000 with the cooperation of the U.S., Russia, many European nations, Japan, Canada, and Brazil. It is currently staffed by two astronauts from NASA, three cosmonauts from Russia and an astronaut from the European Space Agency.

### Use as a prosthetic

Rasmussen is also exploring whether Synthetic Muscle™ could be used as a prosthetic liner. The vestigial limbs of amputees can expand and contract during the day and the Ras Labs material is designed to expand and contract so it could make prosthetics more comfortable. She recently received a grant from the Pediatric Medical Device Consortium at Children's Hospital of Philadelphia to research this possibility.

[Ras Labs](#) is a high tech woman-owned small business. 🍷



The Dragon spacecraft on top of the Falcon 9 rocket. (Photo courtesy of NASA)



The Dragon spacecraft in orbit. (Photo courtesy of NASA)

# COLLOQUIUM

## A Wild Solution for Climate Change

**Professor Thomas E. Lovejoy**  
George Mason University



**Wednesday, April 15**

2 p.m. to 3:30 p.m., M.B.G Auditorium, Lyman Spitzer Building

## Earth Week at PPPL



### April 21

**10:30 a.m.**

**Grounds Cleanup**

Sign up at <http://tinyurl.com/ppplcleanup>

Lunch provided to volunteers

April 23 rain date

### April 22

**7:30 to 10:30 a.m.**

**UNICOR electronics collection**

Lower parking lot at warehouse

**10 a.m. to 11 a.m.**

**Vendors, displays, raffles, and prizes**

LSB Lobby

**11 a.m.**

**Green Machine awards**

MBG Auditorium

**11:30 a.m.**

**Lunchtime movie "The Burden"**

MBG Auditorium

Bring your lunch and get a free snack

**4:15 p.m.**

**"Efforts in New Jersey to Prepare for a Changing Climate"**

Jeanne Herb, Associate Director,  
Environmental Analysis and Communications  
Group, Edward J. Bloustein School of  
Planning & Public Policy, Rutgers University



Volunteers outside the LSB during the Earth Week cleanup last year.



One of the vendors at last year's Earth Day celebration shows Dana Eckstein some biodegradable cleaning products.

## Zwicker to give TEDx talk on Science Education

Andrew Zwicker, head of Science Education, will take part in a TEDxCarnegieLake event on the theme of “Revive,” on April 25 from 12 to 4 p.m. at the Princeton Public Library.

Zwicker’s talk will be “Revive Science Education.” He is among 10 speakers and two performers for the event, ranging from a Buddhist nun discussing “Revive Oneself,” to a representative from Climate Central discussing, “Revive Global Climate.”

This is Zwicker’s third TEDxtalk. He will discuss New Jersey’s long history of

innovation and how we need to revive science education through events like PPPL’s Young Women’s Conference in order to make sure that tradition continues.

Zwicker’s 2013 talk at a TEDx event at Saint Peter’s University, “Fusion Energy, Utopian or Practical,” is available on [YouTube](#).

You must purchase tickets to attend the event. Tickets cost \$25 for regular admission and \$13 for students and senior citizens. The library is located at 65 Witherspoon St., Princeton.

[More information on the event is available here.](#)

## Volunteer for Communiversity!

Come join in the fun at Communiversity Festival of the Arts on Sunday, April 26 from 1 to 6 p.m. The annual event, sponsored by Princeton University and the Arts Council of Princeton, attracts thousands of visitors and features more than 200 artists, crafters, merchants and organizations from the area. We need PPPL volunteers at the PPPL booth to talk to members of the public, help with demonstrations and hand out prizes. Please contact Jeanne Jackson DeVoe, [jjackson@pppl.gov](mailto:jjackson@pppl.gov), ext. 2757 to volunteer.



[More information about Communiversity is available at the Arts Council of Princeton website.](#)

# Brock & Co. Presents The Celebrity Guest Chef Series

Some of the biggest names in the business, from Gordon Ramsey to Paula Dean, will be right here at The Brock Café... Kind of.

Each month we will feature some of the favorite dishes of some of today's brightest culinary stars, preparing the recipes from the "Guest Chef's" own cookbook.

Everyone who purchases the featured special will not only enjoy a wonderful meal, but will also be entered into a drawing to win one of several of the "Guest Chef's" cookbooks that will be given away that day.

## APRIL: Alton Brown "Feasting on Asphalt"

Fried Catfish, Delta Coleslaw, Red Beans, Rice & Filet, Creamed Spinach & Nana Deane's Pecan Coconut Pie

## MAY: Anthony Bourdain "Les Halles"

## JUNE: Paula Dean "Southern Cooking Bible"

**BRÖCK**

**MARK GAZO**  
Chef Manager



BREAKFAST ..... 7 a.m. • 10 a.m.

CONTINENTAL BREAKFAST ..... 10 a.m. • 11:30 a.m.

LUNCH ..... 11:30 a.m. • 1:30 p.m.

SNACK SERVICE ..... until 2:30 p.m.

	Monday April 13	Tuesday April 14	Wednesday April 15	Thursday April 16	Friday April 17
<b>COMMAND PERFORMANCE Chef's Feature</b>	<b>General Tso's Chicken over Rice</b>	<b>Baked Ziti</b> Served with Garlic Bread	<small>CELEBRITY CHEF ALTON BROWN</small> <b>Fried Catfish,</b> Delta Coleslaw, Red Beans, Rice & Filet, Creamed Spinach & Nana Deane's Pecan Coconut Pie	<b>Mushroom Pork Chop</b> Served with Cheddar Broccoli Rice	<b>English-Style Fish &amp; Chips</b>
Early Riser	<b>Greek Omelet</b> with Spinach, Tomato & Feta Cheese Served with Home Fries	<b>Steak, Egg &amp; Cheese Quesadilla</b>	<b>Egg &amp; Cheese Scramble in a Pita</b>	<b>Eggs Benedict Day!</b>	<b>Cranberry Pancakes</b> Served with Choice of Breakfast Meat
Country Kettle	<b>Tomato Bisque with Shrimp</b>	<b>Cajun Gumbo</b>	<b>Cheddar, Potato Chive</b>	<b>Split Pea with Ham</b>	<b>Black Bean Cilantro</b>
Grille Special	<b>Sunny Side Up Burger</b>	<b>Pepperoni Cheesesteak</b> on French Bread	<b>Chicken, Prosciutto, Provolone and Balsamic</b> on a Kaiser Roll	<b>Homemade Chicken Tenders</b> with Waffles and Spicy Maple Syrup	<b>Grilled 4 Cheese, Tomato &amp; Basil</b> on Texas Toast
Deli Special	<b>Grilled Tofu &amp; Vegetable Kabobs</b> with Mediterranean Cous Cous	<b>Beef Gyro</b>	<b>Turkey, Corned Beef, Swiss Cheese &amp; Russian Dressing</b> on Rye	<b>Layered Tuna Club Sandwich</b>	<b>Teriyaki Chicken Sandwich and Asian Salad</b> with Honey Ginger Dressing
Panini	<b>BLT Spread Wrap</b>	<b>Cuban Quesadilla</b> with Ham, Turkey, Swiss, Pickles & Banana Peppers	<b>Chicken Caesar Salad Pizza</b>	<b>Eggplant, Red Onion, Red Pepper and Fresh Mozzarella</b> on French Bread	<b>Ham &amp; Pepper Stack</b>

MENU SUBJECT TO CHANGE WITHOUT NOTICE

Menu Item is in keeping with American Heart Association (AHA) and U.S. Department of Agriculture (USDA) guidelines.

VEGETARIAN OPTION

**WEEKLY**

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The PPPL WEEKLY is published by the [PPPL Office of Communications](#) on Mondays throughout the year except for holidays.

**DEADLINE for calendar item submissions is noon on WEDNESDAY. Other stories should be submitted no later than noon on TUESDAY.**

Comments: [commteam@pppl.gov](mailto:commteam@pppl.gov) ♦ PPPL WEEKLY is archived on the web at: <http://w3.pppl.gov/communications/weekly/>.