Cuttlefish camouflage inspires new shape-shifting materials

By Maria Temming, Scientific American on 08.03.15
Word Count **601**
Level **MAX**

The cuttlefish was the inspiration for a new 3-D printer that prints materials with modifiable surfaces. Wikimedia Commons

3-D printing is radically transforming fields ranging from jewelry-making to jet engine fabrication. Now innovators are moving beyond the production of solid, static objects to create materials that can be transformed and manipulated at will. Using a 3-D printer, engineers have fabricated a new soft material with a modifiable surface texture. The researchers who designed this material have suggested a wide array of applications for such surfaces, but the original inspiration for their shape-shifting creation was the cuttlefish.

“The project was originally about camouflage,” says lead author Mark Guttag, a Ph.D. student at Massachusetts Institute of Technology who conducted this study as part of his master’s thesis. Cuttlefish are cephalopods with large, elongated bodies and tentacles around their mouths. They often hide from predators by altering skin color and patterns to closely blend in with their surroundings. Even more intriguingly, they can match their skin’s texture to that of surrounding surfaces. Octopuses and other cephalopods similarly camouflage themselves.

Inspired by these aquatic masters of disguise, Guttag and co-author Mary Boyce, dean of engineering at Columbia University, wanted to create their own artificial surfaces with adjustable textures. To do so, they developed a 3-D printing process that uses two types of polymers: one rigid, one flexible. The printer inserts an array of the rigid polymers into a bed of squishy material composed of the more flexible type. When the material is compressed, its naturally smooth surface takes on a patterned texture that depends on the spacing and shapes of the embedded rigid polymers. It can be smooth, ridged or bumpy or can even form more complicated patterns. When the material is released, it reverts to its original smooth texture.

Shengqiang Cai, an engineer at the University of California, San Diego, who was not involved with this study, says that Guttag and Boyce's material is "innovative and inspiring." According to Cai, the creation of this method for creating modifiable surfaces not only has many important applications for surface engineering but may also provide valuable insights into the underlying mechanics of biological surface patterning.

Once the material is printed, its rigid polymers are stuck in a fixed array and cannot change positions relative to one another. But Guttag and Boyce have proposed a number of means for achieving different types of surfaces from the same sheet of printed material. For example, by using elongated rigid polymers instead of spherical ones, scientists could create surfaces that are smooth along one direction but ridged in the opposite direction. Some rigid polymers might yield differently textured surfaces depending on the strength of the applied force. If they are lightly squeezed, they form one texture, but further compression would cause the polymers to rotate relative to one another, creating a different topography. Other polymers could swell or shrink relative to the soft material.

In the sample Guttag and Boyce printed to physically test their code, the rigid polymers were about a centimeter in diameter and the bed of soft material was about a meter across. But according to Guttag, their printing process could be scaled up or down, depending on the material's intended use. "The main thing is the relative sizing of particles and relative spacing of them, as opposed to the absolute size," he says.

The team also has discovered that their modifiable surfaces are useful not only for camouflage but also for a spectrum of other applications such as making an object more or less aerodynamic, reflective or water-repellent. These surfaces might also be useful for controlling fluid flow. It seems that transformable topographies might bring the 3-D printing revolution to a host of new industries.

Quiz

1 Which of the following answer options BEST describes the uses of Guttag and Boyce's 3-D printing method?

(A) It provides a use for rigid and flexible polymers.

(B) It makes a flexible material but only in very small amounts so it is not usable in production.

(C) It is useful for camouflage but has limited uses in other areas.

(D) It creates modifiable surfaces that have applications in surf and biological surface engineering.

2 Which of the following does NOT describe a method Gullag and Boyce used to create an artificial surface with adjustable textures?

(A) They developed a 3-D printer that uses two types of polymers.

(B) They developed a 3-D printer using only flexible polymers.

(C) They developed a 3-D printer that uses elongated rigid polymers.

(D) They developed a printer that could make a flexible polymer but it could only make a flat surface.

3 Read the sentence from the article.

> *According to Cai, the creation of this method for creating modifiable surfaces not only has many important applications for surface engineering but may also provide valuable insights into the underlying mechanics of biological surface patterning.*

Which of the following words or phrases from the article helps to explain the meaning of the word "modifiable" as used in the above sentence?

(A) stuck in a fixed array

(B) it reverts to its original smooth texture

(C) material is compressed

(D) strength of the applied force

4 Read the sentence from the article.

> *Inspired by these aquatic masters of disguise, Guttag and co-author Mary Boyce, dean of engineering at Columbia University, wanted to create their own artificial surfaces with adjustable textures.*

Which sentence from the article BEST helps explain the word "aquatic" in the sentence above?

(A) “The project was originally about camouflage,” says lead author Mark Guttag, a Ph.D. student at Massachusetts Institute of Technology who conducted this study as part of his master’s thesis.

(B) Octopuses and other cephalopods similarly camouflage themselves.

(C) They often hide from predators by altering skin color and patterns to closely blend in with their surroundings.

(D) Even more intriguingly, they can match their skin’s texture to that of surrounding surfaces.

Diamond in the rough: Gem coating may protect smartphone screens

By Morgan Peck, Scientific American on 04.13.17

Word Count **778**

Level **MAX**

This is a collection of 0.02, 0.03 and 0.04-carat solitaire diamonds weighing in total 5.36 carats. Photo by: Swamibu/Wikimedia Commons

People cherish diamonds for their beauty and the sense of status and permanence they convey to the wearer, but someday soon these most precious of stones may serve an even more practical purpose than filling out engagement rings and anniversary pendants: protecting smartphone displays from the chips and spider web-like cracks that develop after countless drops and hours of tapping and swiping.

Unlike the nuggets mined from deep in Earth's crust, display-screen diamonds would be grown in the lab of AKHAN Semiconductor, a company developing ways to use synthetic diamonds to enhance electronics. By the end of the year AKHAN plans to begin making glass smartphone screens coated with a microns-thick layer of diamond, which the company says will be more scratch-resistant and less prone to shattering. The company will not say, however, which smartphone makers might use its Miraj Diamond Glass or how it would keep the cost of those screens affordable.

Regardless of whether AKHAN delivers, the idea of using diamonds to solve the widespread problem of cracked smartphone screens bears scrutiny. A Motorola study from a couple of years ago noted nearly a third of U.S. smartphone users have handsets with cracked screens and that many continue to use those screens even after cutting a finger on them. Diamond is the hardest bulk material found in nature, and synthetic versions are likely to be more resistant to scratching than the Corning Gorilla Glass used to make most smartphone displays or even the sapphire crystal that Apple uses for its Apple Watch displays.

Despite its scratch and heat resistance, however, diamond is actually a very brittle material. “If you put enough stress on it, it will break and cleave along the weakest planes,” says Jim Butler, a consultant in chemical vapor deposition who spent 38 years as a researcher at the Naval Research Laboratory. Nor would a diamond coating necessarily protect the underlying glass screen from a drop that creates a blunt force into the screen or along its edges. At that point you’re back to counting on the strength of the glass or whatever material is used to make the original display screen, says Anthony Schiavo, an analyst with technology research firm Lux Research who specializes in advanced materials.

Although screens coated with synthetic diamonds are expected to be more shatterproof than existing smartphone screens, their actual strength depends entirely on the way they are made. The process — known as chemical vapor deposition — involves dusting a substrate, such as a piece of glass, with a layer of fine diamond particulates made up of hydrogen-carbon bonds. The diamond-coated glass is then put into a chamber with a combination of hydrogen and a carbon-rich gas such as methane. The next step is to blast the hydrocarbon gas mixture with heat or subject it to an electromagnetic field until it turns into a plasma of carbon atoms and positively charged hydrogen ions. Under these conditions the diamond particles’ carbon-hydrogen bonds begin to break. A continuous diamond film forms as the hydrogen atoms in the diamond particulates are replaced with carbon atoms from the plasma. Structural defects can be introduced during the process due to variations in temperature or the size of the original diamond particles that determine the physical properties of the end product. Making a more shatterproof diamond film would require tweaking these variables.

As the diamond fragments come together, bonds between the carbon and hydrogen are being made or broken at a furious rate, which pumps energy into the diamond film and generates heat. “The optimal temperatures for growing diamond tend to be above 600 degrees centigrade (Celsius) and, depending on the situation, can be as high as 1,200,” Butler says. Diamond, which is extremely good at dissipating heat, stands up just fine in this extreme environment. Unfortunately, the underlying glass begins to melt at about 550 degrees Celsius.

AKHAN founder Adam Khan claims his company can make a synthetic diamond film at temperatures of 350 degrees C or lower. Butler is skeptical, pointing out the glass and its diamond coating will have different reactions even at those temperatures. “If you’re going to put diamond on something and that something is going to go through temperature cycles, there’s going to be a stress between the coating and the substrate,” he says. Such stresses are enough to crack quartz, which is considerably harder than glass. That challenge can be solved, he adds, “but it’s not a trivial problem.”

AKHAN’s ability to solve such problems will determine whether diamonds end up being a smartphone user’s best friend—or just another way for Apple, Samsung and other device makers to justify driving up the cost of their handsets.

Quiz

1 Read the sentence from the article.

> *As the diamond fragments come together, bonds between the carbon and hydrogen are being made or broken at a furious rate, which pumps energy into the diamond film and generates heat.*

What does the phrase "furious rate" convey in this sentence?

(A) a sense of how much heat is being generated during the chemical procedures involved in making a diamond film

(B) a sense of how much energy needs to be provided by scientists working with simulated diamonds in a lab setting

(C) a sense of how quickly chemical bonds change during the process of creating a simulated diamond film

(D) a sense of how intricate the procedure is for bringing diamond fragments together to form a film

2 Read the sentence from the article.

> *Regardless of whether AKHAN delivers, the idea of using diamonds to solve the widespread problem of cracked smartphone screens bears scrutiny.*

What does the author mean by the phrase "bears scrutiny" in the sentence?

(A) AKHAN's idea of developing more durable smartphone screens is worth watching closely.

(B) AKHAN's idea of developing more durable smartphone screens is completely unrealistic.

(C) AKHAN's idea of developing more durable smartphone screens is impossible to fulfill.

(D) AKHAN's idea of developing more durable smartphone screens is clearly a success.

3 Which of the following options BEST describes the structure of the article?

(A) The article introduces a product and compares it with current products that are on the market.

(B) The article introduces an idea and details the procedures that would be necessary for it to come to fruition.

(C) The article describes a new company that has been founded and outlines its plan to break into the smartphone market.

(D) The article questions the reliability of various products manufactured for smartphones.

4 Is the first paragraph an effective way to engage readers on the topic of using diamonds in smartphone products? Why or why not?

(A) Yes, because it describes diamonds in a way that most readers would be familiar with.

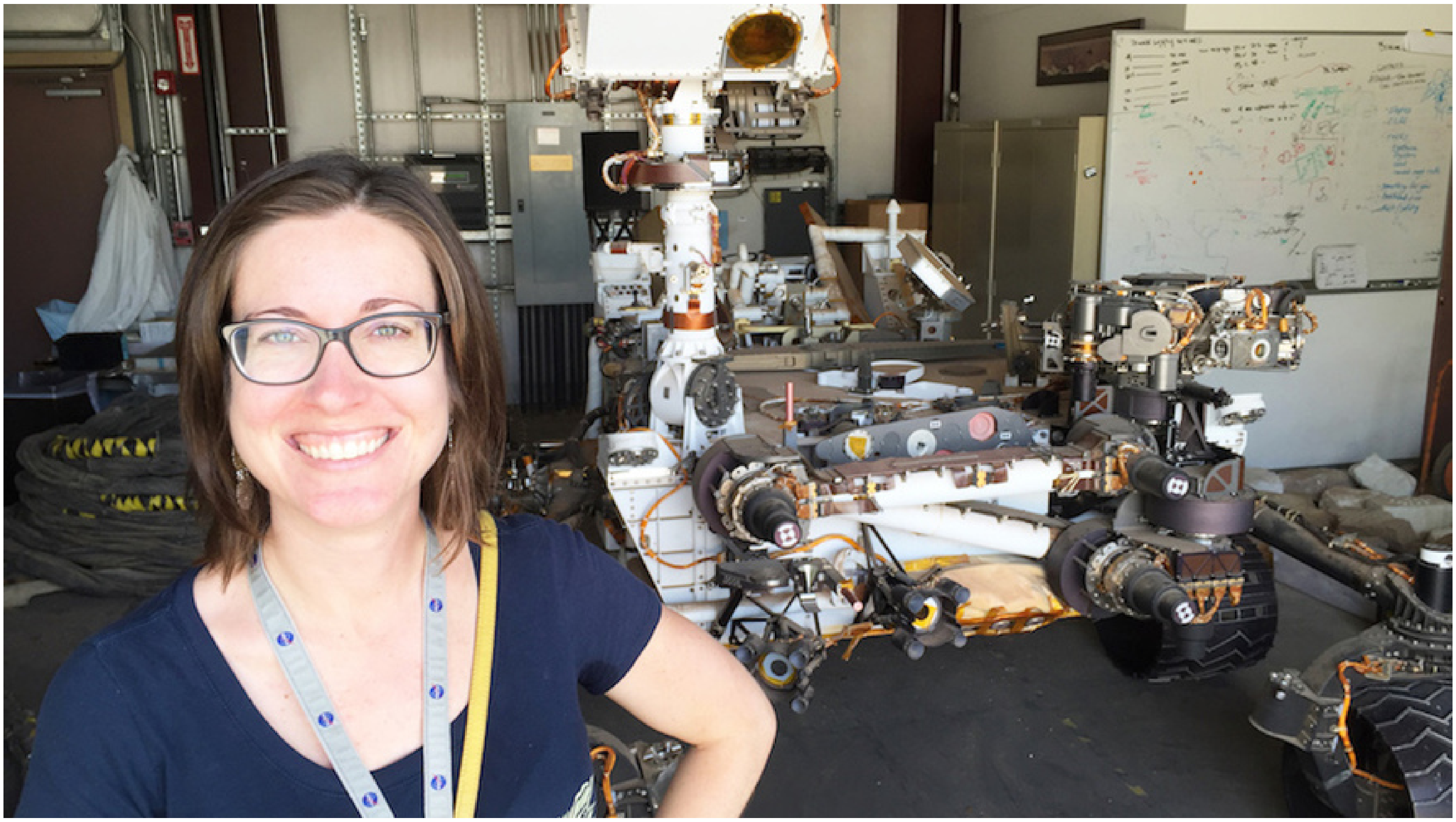
(B) No, because it does not describe the chemical procedures involved in creating simulated diamonds.

(C) Yes, because it explains the properties of diamonds that make them ideal for use in smartphones.

(D) No, because it does not reveal how widespread the problem of cracked smartphone screens is.

Dream Jobs: Science writer

By NASA.gov on 12.05.16
Word Count **1,042**
Level **MAX**



TOP: Katie McKissick pays a visit to the engineering model of Curiosity at the Mars yard at NASA's Jet Propulsion Laboratory in California. Courtesy of NASA. SECOND: McKissick visits baby goats at the Chivas Farm in Fillmore, California. Courtesy of NASA.

Katie McKissick is a science writer at NASA.

Where are you from?

I'm from Reno, Nevada, otherwise known as the "biggest little city in the world." People tend to think it's near Las Vegas at the southern end of the state, but it's actually about 400 miles away in the foothills of the Sierra Nevada Mountains. I spent summer days swimming in the icy waters of Lake Tahoe and winters sledding, skiing and snowboarding in the mountains.

Describe the first time you made a personal connection with outer space.

I always loved looking at the night sky and spotting constellations I recognized, but I distinctly remember a time when I got a really good glimpse of the starry sky with little light pollution. I was lying on a dock at Lake Tahoe; the lake providing a buffer from the few lights of nearby lake houses. It was by far the most stars I had ever seen, and I could barely believe how many there were. I still have never been anywhere so dark that I could see the haze of the Milky Way, but that's on my to-do list.

How did you end up working in the space program?

I got here in a very roundabout way.

Starting in high school, I was really interested in science, but never felt drawn to any one field in particular. I found them all so fascinating that I couldn't bring myself to choose. In college I delved into biology and chemistry, but I still didn't know what I would do with my degree. In the end I thought being a science teacher would be a good fit for me and would allow me to give back to my community, but I planned to return to graduate school eventually to further study science. During my brief teaching career, I realized that explaining science to others, rather than doing the science itself, was what truly interested me. After that, I decided I wanted to be a science writer.

With no science writing experience, I started my own science blog while I worked at an unrelated day job to pay the bills. For years I wrote and published science articles, honing my writing skills and growing an audience. It was this experience that allowed me to get a job writing about planetary science at NASA's Jet Propulsion Laboratory in Pasadena, CA.

What missions have you worked on?

I've produced content for several NASA websites, including Solar System Exploration, the Cassini mission, Space Place, Climate Kids, and NOAA's SciJinks.

Who inspired you?

My mother and maternal grandfather have always inspired and encouraged me.

From the moment I could talk, my mom would always answer my strange questions and have deep conversations with me (when other adults would have laughed at or ignored me). She taught me to be kind but also to stand up for myself. Her bravery, wisdom, honesty, integrity and brilliance have always inspired me and set an example for me to follow. In everything I do, I try to be as much like my mom as I can.

And it was my grandfather who first suggested that I become a science writer, even though he was still hoping I'd follow in his footsteps and become a doctor. At the time being a science writer sounded so completely unattainable that I thought he might as well have suggested I be the president of the United States. But I always kept it in the back of my mind, and it turns out -- just like he was about so many other things -- he was right.

What does your job entail?

I'm a science communicator, which means I produce content that explains science and engineering concepts. Sometimes it's an article; other times it's a video, illustration, infographic or interactive website.

On my team, I'm primarily a writer, so my job is all about reading and writing. Each day I read up on the latest news in science and engineering, and then I start tackling my writing to-do list. Some days I have meetings with my colleagues where we make editorial decisions about what to write about, how best to cover it, when to publish it, and how to engage our audience. I really enjoy thinking strategically about how we can best explain to the public what is going on in the world of science and engineering.

Another big piece of my job is updating the website, which means accessing the code of the site and making additions and changes. Sometimes this also involves redesigning the looks of pages and finding new and exciting ways to use the power of web design to tell engaging science stories.

What advice would you give someone who wants to take the same career path as you?

Don't be discouraged if you can't get a day job in science communication right away. No one can stop you from doing it on your own, and you can define your own success that way. Start a website, a blog, or even just a Twitter account. Start doing what you want to do and see where it leads.

And if you're still searching for your career path, have patience and let yourself explore different options. I have often heard people say, "Do what you love." This is incomplete advice, and it frames what you do in very self-centered terms. I found it more helpful to ask myself what I feel passionate about and what I can contribute to it -- not what it can do for me. It's very John F. Kennedy: "Ask not what your country can do for you; ask what you can do for your country." Besides, no matter how much you like something, there will be challenges and frustrations here and there. And during tough times, the feeling that you're doing something that fits your values and makes the world (even in a very small measure) a better place is what will truly be sustaining in the long run.

What do you do for fun?

My simplest pleasure is taking my dog for a long walk, watching her lose her mind over grass, flowers and squirrels. I also like drawing, animating and painting.

Quiz

1 Which option would Katie McKissick MOST likely agree with? Which sentence from the text supports your answer?

(A) You should always stick with your first career choice; During my brief teaching career, I realized that explaining science to others, rather than doing the science itself, was what truly interested me.

(B) It does not take much work to become a science writer; Each day I read up on the latest news in science and engineering, and then I start tackling my writing to-do list.

(C) It is important to have people in your life who inspire you; Another big piece of my job is updating the website, which means accessing the code of the site and making additions and changes.

(D) You should do a job where you feel you are giving back to that field; I found it more helpful to ask myself what I feel passionate about and what I can contribute to it -- not what it can do for me.

2 Which option is BEST supported by the paragraph below?

And it was my grandfather who first suggested that I become a science writer, even though he was still hoping I'd follow in his footsteps and become a doctor. At the time being a science writer sounded so completely unattainable that I thought he might as well have suggested I be the president of the United States. But I always kept it in the back of my mind, and it turns out -- just like he was about so many other things -- he was right.

(A) McKissick's grandfather was disappointed in her when she did not become a doctor.

(B) Having someone believe in her gave McKissick the confidence to get the job she loves.

(C) Most of the people in McKissick's family have had jobs in politics and government.

(D) There were no other jobs that seemed as interesting to McKissick as being a science writer.

3 What purpose is served by including examples of what McKissick does each day?

(A) The examples illustrate the various aspects of being a science writer for readers who are interested in the field.

(B) The examples illustrate how challenging and frustrating being a science writer is every single day.

(C) The examples illustrate the elements of being a science writer that are most like McKissick's first job as a teacher.

(D) The examples connect the aspects of being a science writer with the topics McKissick most loved as a child.

4 Read the sentences below. How does the relationship between these two sentences develop the main idea of the article?

With no science writing experience, I started my own science blog while I worked at an unrelated day job to pay the bills.

And if you're still searching for your career path, have patience and let yourself explore different options.

(A) Both suggest that McKissick was initially unsure that she wanted to become a science writer.

(B) Both develop the idea that it takes time and experience to find a career that works for you.

(C) The first shows how McKissick decided what she wanted to do and the second shows the way she started out in the field.

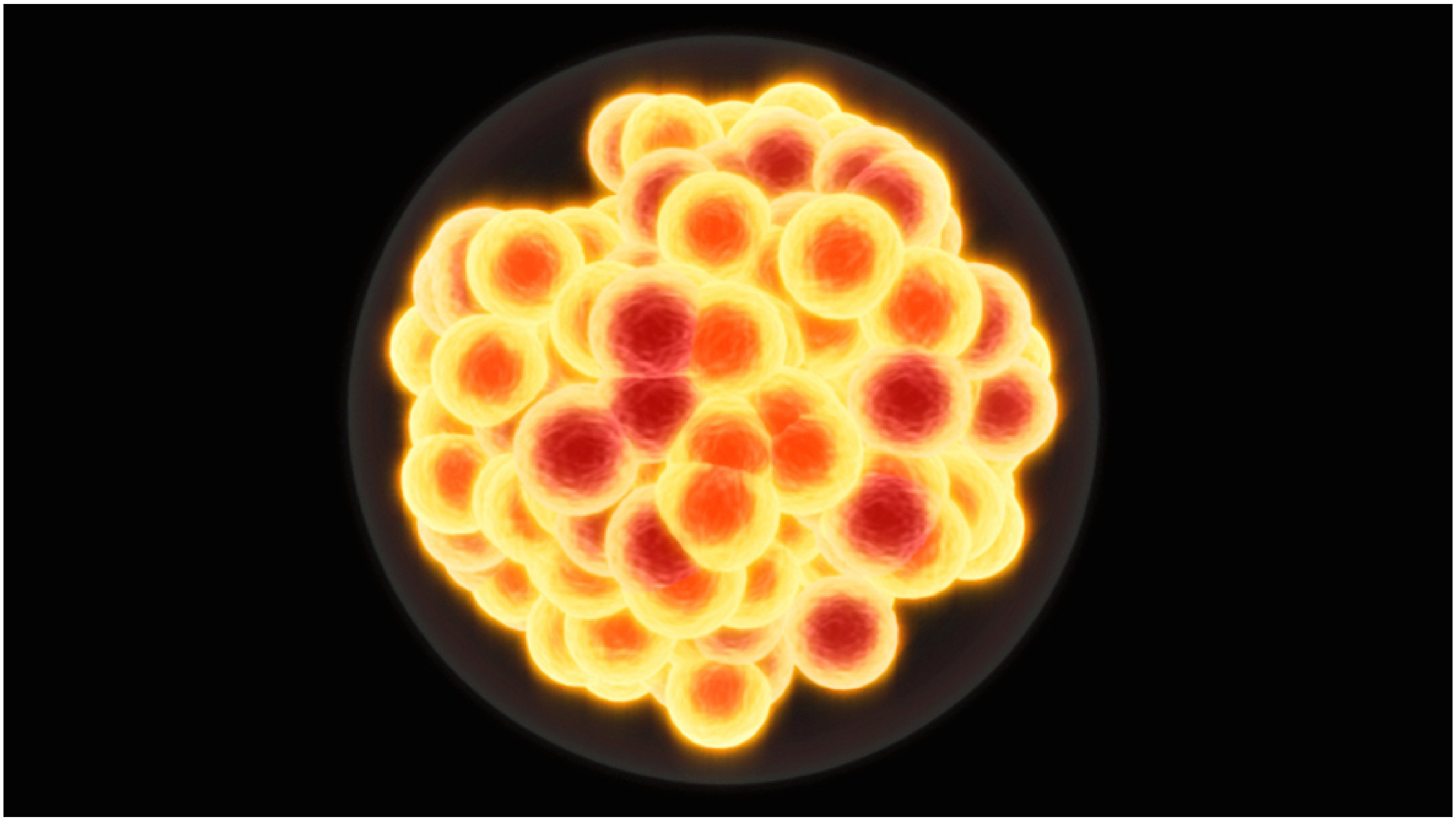
(D) The first explains that having no experience was not a factor in McKissick's job choice and the second explains traits she needed to have.

Four super-heavy elements to be added to the periodic table

By Deborah Netburn, Los Angeles Times on 01.13.16

Word Count **715**

Level **MAX**



An illustration of the newly created element 117. Kwei-Yu Chu / Lawrence Livermore National Laboratory

The periodic table is about to get a little bit longer, thanks to the addition of four super-heavy elements.

The discoveries of elements 113, 115, 117 and 118 were confirmed last week by the International Union of Pure and Applied Chemistry. The group vets the man-made elements seeking a permanent spot on the chart that adorns chemistry classrooms around the world.

The new elements are known as super-heavy elements because the nuclei of their atoms are so enormous. Element 118, for example, is the heaviest element to date, with 118 protons alongside 176 neutrons.

Elements of this size are not routinely found in nature, and it can take years to make them in specialized laboratories.

“Probably the only other place where they might exist in a short period of time could be a supernova, where you have so much energy and so many particles that are really heavily concentrated," said Dawn Shaughnessy, the principal investigator for the Heavy Element Group at Lawrence Livermore National Laboratory, which had a hand in three of the discoveries.

Super-heavy elements are also highly unstable, existing for just a fraction of a second before they begin to decay.

Scientists never observe these elements directly. Rather, they know they briefly existed because they are able to measure their decay products.

The heaviest known elements are made by smashing two particles together and hoping they will stick. It's a probability game with extremely long odds.

Scientists first create a target out of a carefully chosen atom with a particular number of protons and neutrons — a process that can take months. Then they purify it and bombard it with another specialized atom that they think has the best chance of recombining with the target.

"It's really hard to smash two things together and get them to stick," Shaughnessy said. "There is so much positive charge — they want to repel each other."

It takes several months to try this smashing experiment roughly 10 quintillion times (10 followed by 18 zeros). If just one of those attempts works, the experiment is considered a success.

"And we're not always successful," she said. At most, it will work about three times in 10 quintillion tries, she said.

There are only a few laboratories around the world equipped to do this work. The experiments generate so much data that supercomputers are required to sift through it all and search for signs of a successful mash-up.

Elements 115, 117 and 118 were created in Russia, at the Joint Institute for Nuclear Research. Scientists from Lawrence Livermore worked on all three discoveries, and the consortium that created element 117 also included researchers from the Oak Ridge National Laboratory in Tennessee and the University of Nevada, Las Vegas.

The international chemistry body credited a Japanese group with the discovery of element 113. Led by Kosuke Morita of RIKEN, they are the first Asian scientists to find a new element.

Morita and his team spent several years searching for conclusive proof of element 113. During that time, whenever Morita visited a Japanese shrine, he gave an offering of 113 yen.

"It's not really a question of whether I believed it or not," Morita told Asian Scientist Magazine. "The reason I did it is that I wanted to know that I had done everything humanly possible to get credit for the discovery of the element."

Until now, these elements have been known by the generic Latin names ununtrium, ununpentium, ununseptium and ununoctium. Their confirmation paves the way for them to get permanent names. Traditionally, that honor falls to the researchers who first found them.

The team from Lawrence Livermore and their Russian colleagues had previously named element 116 Livermorium in honor of the Northern California lab. No word on what 115, 117 and 118 might be called.

With last week's announcement, 26 elements have been added to the periodic table since 1940. But Shaughnessy said her team isn't done.

The scientists will continue trying to make heavier elements until they hit a wall where there are just so many protons that they won't stick together.

"These super-heavy elements help us understand how the nucleus functions and redefines our ideas of matter and how it behaves," she said. "We're really studying the physics of what the extreme limits of matter might be."

Quiz

1 Which of the following excerpts from the article illustrates the difficulty of interpreting results from the experiment?

(A) Scientists first create a target out of a carefully chosen atom with a particular number of protons and neutrons — a process that can take months. Then they purify it and bombard it with another specialized atom that they think has the best chance of recombining with the target.

(B) "It's really hard to smash two things together and get them to stick," Shaughnessy said. "There is so much positive charge — they want to repel each other."

(C) It takes several months to try this smashing experiment roughly 10 quintillion times (10 followed by 18 zeros). If just one of those attempts works, the experiment is considered a success.

(D) Super-heavy elements are also highly unstable, existing for just a fraction of a second before they begin to decay.

Scientists never observe these elements directly. Rather, they know they briefly existed because they are able to measure their decay products.

2 Read the following selection from the article.

It takes several months to try this smashing experiment roughly 10 quintillion times (10 followed by 18 zeros). If just one of those attempts works, the experiment is considered a success.

"And we're not always successful," she said. At most, it will work about three times in 10 quintillion tries, she said.

Which of the following conclusions can be drawn from the selection above?

(A) Experiments that try to find new super heavy elements take many attempts.

(B) Experiments involving super-heavy elements are repeated until the successful combination is found, no matter how long it takes.

(C) Experiments involving super-heavy elements do not yield reliable data unless they are repeated many times.

(D) Experiments involving super-heavy elements are successful only if they can be repeated three times.

3 Read the following two paragraphs from the article.

The scientists will continue trying to make heavier elements until they hit a wall where there are just so many protons that they won't stick together.

"These super-heavy elements help us understand how the nucleus functions and redefines our ideas of matter and how it behaves," she said. "We're really studying the physics of what the extreme limits of matter might be."

How does paragraph 1 reinforce paragraph 2?

(A) It reflects how scientists intend to keep trying to make heavier elements even if they hit a wall.

(B) It describes how scientists will go to any extreme to learn about super-heavy elements.

(C) It shows how scientists will continue to work together to redefine the nucleus.

(D) It explains the lengths scientists are willing to go to extend understanding of physics.

4 Which paragraph from the article BEST summarizes a central idea from it?

(A) It takes several months to try this smashing experiment roughly 10 quintillion times (10 followed by 18 zeros). If just one of those attempts works, the experiment is considered a success.

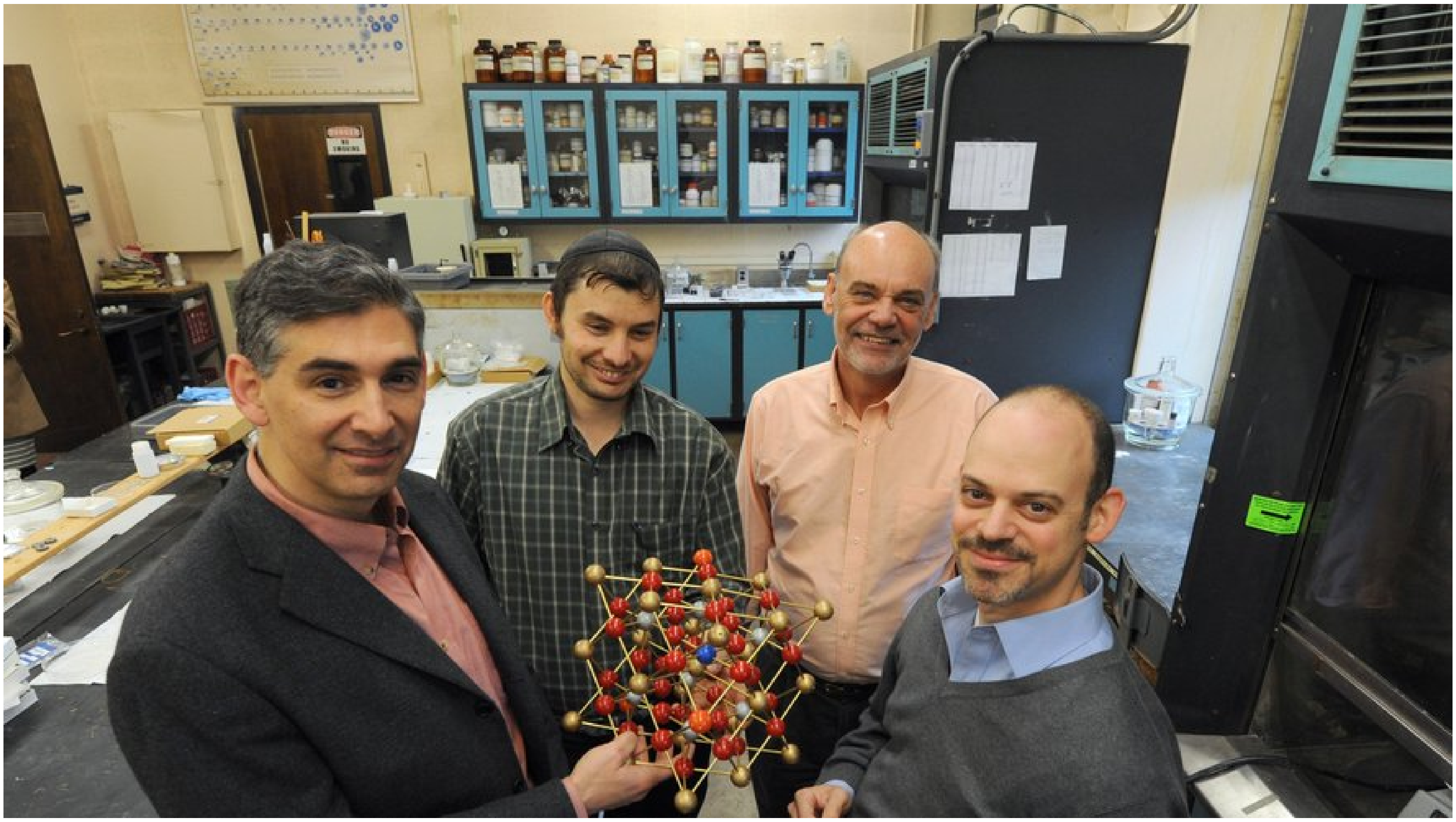
(B) The new elements are known as super-heavy elements because the nuclei of their atoms are so enormous. Element 118, for example, is the heaviest element to date, with 118 protons alongside 176 neutrons.

(C) There are only a few laboratories around the world equipped to do this work. The experiments generate so much data that supercomputers are required to sift through it all and search for signs of a successful mash-up.

(D) Until now, these elements have been known by the generic Latin names ununtrium, ununpentium, ununseptium and ununoctium. Their confirmation paves the way for them to get permanent names. Traditionally, that honor falls to the researchers who first found them.

Scientists seek a newer, cheaper solar panel

By Tom Avril, The Philadelphia Inquirer on 11.27.13
Word Count **679**
Level **MAX**



A Penn-Drexel team including (from left) scientists Andrew M. Rappe, Ilya Grinberg, Peter Davies and Jonathan E. Spanier, pictured Nov. 15, 2013, in Philadelphia, has invented a photovoltaic crystal. April Saul/Philadelphia Inquirer/MCT

PHILADELPHIA – Solar panels generate electricity by absorbing sunlight, but that is only half the battle. Once electrons in the panel are energized, they must be channeled in the same direction – a process that typically requires a panel made with layers of two kinds of material.

Not in the future, if a team of researchers from the University of Pennsylvania and Drexel University can help it.

In a new study published online by the journal Nature, the scientists reported they had created a new class of ceramic material that could accomplish both tasks cheaply and efficiently.

So far the group has created just tablet-size bits of the new ceramic, but members predict it can be used to make panels that are better at harvesting energy and less expensive than the silicon-based models that dominate the market.

The authors say their new ceramic also would have an edge over "thin-film" solar panels, which tend to contain materials that are rare, toxic, or both. The new material contains potassium, niobium, barium and nickel, which are relatively abundant and environmentally benign.

So is silicon, but it requires lots of processing and manufacturing to be used in solar panels. The authors say their combination of materials will be cheaper in the long run.

"We've opened up a new category of ways of making a solar cell," said Penn chemistry professor Andrew M. Rappe, who supervised modeling and computation for the project.

Solar power remains a small player on the nation's energy scene, accounting for just a quarter of 1 percent of energy consumed in 2012, according to the U.S. Energy Information Administration. The actual numbers are higher, according to the Solar Energy Industries Association, which says the government does not have complete data on rooftop panel installation.

But by any measure, solar power generation has been climbing steadily, driven in part by government incentives. And for scientists, the sun remains a tantalizing source of untapped power.

Materials that can channel the flow of electrons are described as having polarity, and have been known to science for decades. But they have not been used to make solar panels because they primarily absorb energy from ultraviolet light, not from the visible part of the spectrum.

The Penn-Drexel team started with one of these polar materials, called potassium niobate, then used computer models to predict what other elements could be added so that it would absorb visible light.

The eventual winners were barium, which replaces some of the potassium in the structure of the ceramic crystal, and nickel, which replaces some of the niobium.

"The nickel is really doing the job," Rappe said. "The barium's kind of along for the ride."

Other authors of the paper included research specialist Ilya Grinberg and materials science professor Peter K. Davies, both from Penn, and Jonathan E. Spanier, a Drexel associate professor of materials science and engineering.

The manufacture of the material involved a multistep process of grinding and heating. By adding different amounts of barium and nickel, the scientists found they could tweak the material so that it could absorb varying wavelengths of visible light.

In theory, this type of ceramic could realize efficiency above 50 percent, though a lot of work remains to be done, the authors said.

Lane W. Martin, an assistant professor of materials science and engineering at the University of Illinois at Urbana-Champaign, agreed that the approach had potential.

"It's a pretty promising first step in this realm," said Martin, who was not involved with the research.

Rappe said the research came about in part through Pennergy, an interdisciplinary program that provides funds for projects involving both engineers and representatives from the pure sciences at Penn, Drexel and Temple University.

Among other sources, the authors also were funded by Ben Franklin Technology Partners, a state-backed economic development program.

Future research will involve actually making a solar "cell," complete with electrodes, yet Spanier was plenty excited by the small tablets. The Drexel researcher conducted tests revealing that the material had the desired properties.

"It's a mixture of excitement and satisfaction and thrill," he said.

Quiz

1 Which of the following aspects is NOT thoroughly discussed in the article?

(A) how the new ceramic is made

(B) how efficient the new ceramic might be

(C) how the researchers were supported for their work

(D) how much money this new technology would save

2 Which excerpt from the article MOST supports the claim that solar power is an important new source of energy?

(A) Solar panels generate electricity by absorbing sunlight, but that is only half the battle. Once electrons in the panel are energized, they must be channeled in the same direction – a process that typically requires a panel made with layers of two kinds of material.

(B) Solar power remains a small player on the nation's energy scene, accounting for just a quarter of 1 percent of energy consumed in 2012, according to the U.S. Energy Information Administration. The actual numbers are higher, according to the Solar Energy Industries Association, which says the government does not have complete data on rooftop panel installation.

(C) But by any measure, solar power generation has been climbing steadily, driven in part by government incentives. And for scientists, the sun remains a tantalizing source of untapped power.

(D) Future research will involve actually making a solar "cell," complete with electrodes, yet Spanier was plenty excited by the small tablets. The Drexel researcher conducted tests revealing that the material had the desired properties.

3 What is the BEST way to define "benign" using the context below?

> *The authors say their new ceramic also would have an edge over "thin-film" solar panels, which tend to contain materials that are rare, toxic or both. The new material contains potassium, niobium, barium and nickel, which are relatively abundant and environmentally benign.*

(A) risky

(B) harmless

(C) malignant

(D) purifying

4 Using the context from the passage below, what is the BEST way to define "efficiently?"

> *In a new study published online by the journal Nature, the scientists reported they had created a new class of ceramic material that could accomplish both tasks cheaply and efficiently. So far the group has created just tablet-size bits of the new ceramic, but members predict it can be used to make panels that are better at harvesting energy and less expensive than the silicon-based models that dominate the market.*

(A) legally

(B) reputably

(C) realistically

(D) productively