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SYSTEM ALERT!

Tomorrow is almost here.

Battery innovation is **child's play . . . literally!**

Oobleck. That is the bizarre name of a bizarre substance you can make in a couple minutes in your kitchen. And if you have never made this before, definitely put it on your to-do list. Mix one part water with two parts cornstarch. The result is a goopy substance that flows like a liquid but becomes hard as a solid object when you hit it.

Substances that behave this way are called non-Newtonian fluids. Scientists have studied Oobleck, but most see it as just a fun curiosity. Therefore, chemist Gabriel Veith was not expecting a bolt of inspiration when he sat down with his children to play with the substance. The properties of the substance gave him a big idea. That idea, now being developed by his team at Oak Ridge National Laboratory, could change the way many batteries are made and create a safer world.

Lithium-ion batteries are used in many applications from cell phones to electronic cars. However, they are a known fire hazard. They have led to personal injury, garbage truck fires, and even a tragic airplane crash. In 2017, more than half of the waste-facility fires in California were started by lithium-ion batteries!

DON'T LET YOUR ELECTRODES TOUCH

The problem with the batteries is a critical weakness in the structure.

Within the casing, two electrodes with opposite charges create a flow of electricity. These two electrodes are submerged in an electrolyte solution and separated by a thin plastic barrier. But this barrier can be damaged if the product containing the battery is dropped. When this happens, the two electrodes can touch, causing the surrounding electrolyte solution to ignite.

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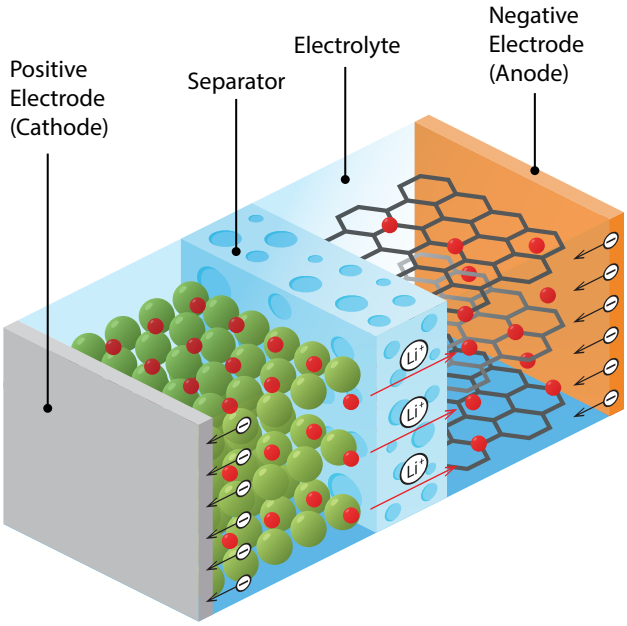
Lithium-Ion battery



AN OOBLECK OF YOUR VERY OWN

It's this simple: Mix one part water and two parts cornstarch.

Now *slowly* press your hand into it. It sinks down into the goop, right? Now, what happens when you hit or slap the mixture? What is different about the way the Oobleck behaves in each circumstance?

Try to vigorously roll a dollop around in your hand. Can you roll it into a solid ball?

Things get really intriguing when a stereo speaker cone is used to vibrate the substance at a frequency of around 30 Hz. Tendrils begin to form, and it takes on a lifelike appearance. Some even say that it dances.

What additional applications can you think of for a substance that flows like a liquid but solidifies under pressure?

DRONE PATROL

Making the skies safe for **humans and birds**

January 15, 2009. Less than two minutes after takeoff, US Airways Flight 1549 suffered a catastrophic mid-air collision with a flock of Canada geese. Both of the passenger jet's engines were destroyed. There was no time to return to the airport.

In an amazing feat of skill, pilot Chesley Sullenberger landed the damaged plane on the surface of the Hudson River. All passengers survived.

This might seem like a rare occurrence, but bird strikes happen more often than you probably think. In fact, the first bird strike happened to the Wright Brothers in 1905! Though they are rarely emergency situations, Flight 1549 proved they can be. How can we prevent another disaster such as this?

One way is to simply reduce the number of birds. After the collision, tens of thousands of wild birds were killed as a preventative measure. But this is not a popular solution. A more favorable option is to keep flocks away from planes in flight. Falcons have been trained to scare away flocks that fly near airports. While this is an interesting solution, it has downsides.

A simpler solution might be to use aerial drones to divert flocks. Engineers at Caltech have been testing this idea out with positive results. The birds react as though the drone were a predator bird.

MODELING A BIRD FLOCK

The first tests used drones remote controlled by humans. But this was not reliable. If the drone pilots used the wrong type of approach, the flock scattered in every direction, creating more havoc in the sky.

Automated drones can be programmed to consistently act with the precision needed to safely redirect a flock. Drones have previously been programmed to herd sheep. This was a helpful starting point, but sheep move in two dimensions, whereas birds move in three. To create effective code, engineers needed to understand the dynamics of a flock in flight. They created a mathematical model of a bird flock.

Based on their model, engineers hypothesized that the best approach causes a ripple effect in the flock. Each bird takes its cue from the birds around it, and with a gentle approach from the right angle, the birds on the outer edge of the flock veer in a predictable way. This causes the rest of the flock to react in kind.

The Caltech researchers tested their idea in Korea. A single drone was able to reliably redirect an incoming flock of dozens of birds. Next, the team is looking at using multiple drones to herd larger flocks.

A FEW USES FOR AERIAL DRONES

- **Land surveying and mapping**
- **Search-and-rescue missions**
- **Monitoring crops and cattle**
- **Law enforcement**
- **Shipping**
- **Combat and espionage**
- **Traffic management**

Algorithm: Recipe for results

When engineers wished to create drones that would herd flocks of birds, remote-controlled drones didn't cut it. (See the "Drone patrol" article.) They needed autonomous drones programmed to react at speeds beyond what a human operator can perform.

To program these aerial drones, engineers created an algorithm. An algorithm is a set of steps that describe how to perform a task. It is written in human language to be understood by humans. Programmers translate the algorithm into a language (code) that computers can understand.

For example, you could write an algorithm to organize a chest of drawers.

1. Starting with the top drawer and moving down, open each drawer and remove the clothes.
2. Sort the clothes into piles by clothing type.
3. Starting with the top drawer and moving down, place each pile into a separate drawer.
4. If you run out of empty drawers before you run out of piles, put the extra piles in the closet.

A robotics programmer could use this set of steps to create code that would describe the task in mathematical logic. Then, a robot could sort your drawers.

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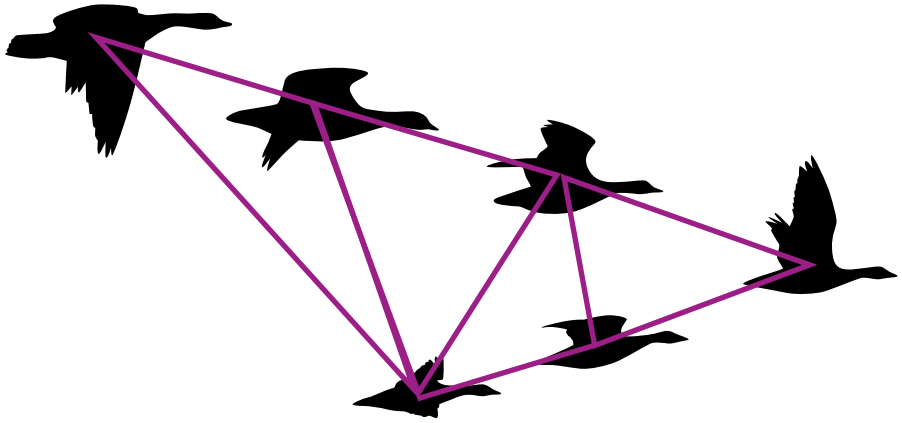
PROGRAMMING CHALLENGE

TETRIX® PRIZM® gives you the power to create autonomous robots. With programming support for Arduino Software (IDE), you will soon be creating robots that carry out your instructions. Can you program a robot to "herd" another robot? How would these two robots work? What sensors would they need?



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Battery innovation is child's play . . . literally!

Veith's big idea is to mix an additive into the battery that transforms the electrolyte solution into a non-Newtonian fluid. Now imagine dropping such a battery. The force of impact may break the plastic barrier, but it will also cause the electrolyte to suddenly seize into a solid, holding the electrodes in place. There is a much lower chance they will touch and cause a fire.

A HARD PROBLEM MADE EASY?

In the world of chemistry, there are many cool ideas that work well in a laboratory but are difficult to scale up for mass production. Some chemical reactions are harder to achieve at the large scales manufacturing processes rely on. It is a frustrating problem for chemists. But in this case, manufacturing the safer batteries should be a breeze. The additive would simply be injected into the battery before the electrolyte solution is.

The additive, by the way, is tiny spherical particles of silica. Silica is found in sand and quartz.

OUT OF THE BOX

The team is eyeing aerial drone batteries as a good starting point for their technology. The reason is that drone crashes have a significant risk of battery damage. There are also other applications in mind, including one really out-of-the-box idea: the team thinks soldiers could use the battery technology as a kind of body armor. Research has shown that the properties of non-Newtonian fluids make them suitable for stopping bullets.

"The battery would function as their armor, and that would lighten the average soldier by about 20 pounds," explained Veith.

Quantum dots – coming to a screen near you

Next time you press your TV's ON button, take a moment to admire the crisp, vibrant image and rich colors. You might take the clear image for granted, but the first television owners would have been truly astonished to see the picture quality we enjoy today. This technology is thanks to decades of engineering. However, there is still room for improvement.

Currently, we are making a leap forward in this field thanks to a burgeoning technology called quantum dots. This technology is enabling engineers to create screens with brilliant color.

Quantum dots are tiny crystals, sometimes called nanocrystals. A more revealing name, however, is artificial atoms.

To understand why they're called artificial atoms, consider this: when atoms are stimulated with energy, they emit certain colors of light. For example, sodium in a hot flame produces yellow light. A heated piece of copper produces green light. The jolt of energy from the heat causes the atoms' electrons to leap. When they settle back down, the atom releases a pulse of light.

Quantum dots perform the same trick. Each quantum dot is made up of hundreds or thousands of atoms, but they react in the same manner thanks to their structure. When light hits a quantum dot, the dot releases a specific color of light.

The size of the dot determines the color. Blue light is produced by a small dot. A slightly larger dot will produce green light. And an even larger one will produce red light.

Engineers can fine-tune these objects for perfect color control. That precise control is what makes quantum dots so promising. In an LCD screen, a layer of quantum dots can be sandwiched into the screen to enhance color.

Even though quantum dots are just getting their start, they are finding their way into more and more products. With each use, engineers are learning how to effectively use them more productively.

LEARN MORE!

SOLAR POWER BOOST

Gorgeous color for our screens is not the only use for quantum dots – not by a long shot. Solar power is another application where quantum dots could prove beneficial.

This is how a standard solar panel works: light strikes a layer of silicon atoms, causing electrons to jump from the atoms into a circuit. This provides electrical current.

However, the same amount of light striking a layer of quantum dots can release up to 10 percent more electrons. That means more current. Ten percent might not sound like much, but engineers have been struggling to make even modest gains in the efficiency of solar panels. This could be a huge boost.

The Ray Catcher Sprint Deluxe Solar Vehicle from Pitsco gives a great foundation for learning about the workings and uses of standard solar panel technology (photovoltaics). These solar panels convert sunlight into electrical current through the excitation of silicon atoms. But because the panel is connected to a vehicle, you can see the power generated immediately.

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Tomorrow is almost here.

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Student name: _____ **Class/Hour**: _____

SySTEM Alert! Quiz (Volume 7, Number 2)

1. Substances that normally flow as liquids but solidify with pressure are called _____.
    A. non-Newtonian fluids
    B. lithium ions
    C. electrolyte solutions
    D. quantum dots

2. When was the first recorded mid-air collision between a bird and an airplane?
    A. 2009
    B. 1967
    C. 1905
    D. 1549

3. Aerial drones have previously been programmed to herd which animal?
    A. cows
    B. horses
    C. cats
    D. sheep

4. What color of light do copper atoms emit when heated with a flame?
    A. purple
    B. yellow
    C. brown
    D. green

5. In a lithium-ion battery, the positive electrode is the _____ and the negative electrode is the _____.
    A. anode, cathode
    B. algorithm, silicon
    C. cathode, anode
    D. silicon, algorithm

6. A(n) _____ is a set of steps that describes how to perform a task.
    A. code
    B. algorithm
    C. survey
    D. electrode

7. How many atoms does it take to make a quantum dot?
    A. one
    B. 32
    C. hundreds or thousands
    D. millions or billions

8. In a standard solar panel, light strikes a layer of _____ atoms, causing electrons to jump from the atoms into a circuit.
    A. copper
    B. sodium
    C. silicon
    D. nanocrystal

9. The recipe for Oobleck is _____.
    A. one part water and two parts cornstarch
    B. two parts water and one part cornstarch
    C. one part electrolyte and two parts silicon
    D. two parts electrolyte and one part silicon

10. In 2017, more than half of waste-facility fires in California were started by _____.
    A. aerial drone crashes
    B. lithium-ion batteries
    C. bird-related airplane crashes
    D. electrons from heated copper

Bonus:
List five new wild ideas for using aerial drones.