SCIENCE CURRENTS

What do vaccines, spaceships, and 3D printing of robotic structures have in common?

While you ponder that question, I am delighted to introduce Science Currents, the new MHS newsletter covering recent developments in a variety of scientific fields. By reading this newsletter, you will have the opportunity to stay up-to-date with the latest innovations in medicine, engineering, environmental science, and much more. Our contributors have selected their topics of interest and now present you with brief yet informative snapshots of perplexing problems and ambitious advancements.

Thank you to Mrs. Brenda From and Mrs. Sheila Minis for launching this exciting new MHS publication, and to all of our student researchers and writers who open our minds to new vistas of the world within and around us. A special thank you goes to Mrs. Dena Szpilzinger and Shaina Reissman for their layout and design assistance.

We hope you enjoy this brief but enlightening journey into the constantly developing world of science, and we look forward to sharing future editions of Science Currents this year.

By the way, we will be very happy to read your original answers to the question above!

To be considered for inclusion in our upcoming editions, your responses to the question, as well as comments and questions about any of the featured articles, may be sent to Mrs. Sheila Minis at tiomnyminiss@manhattanhigh.org.

Expand your mind with Science Currents!!

Mrs. Nechama Mirsky
Principal, General Studies

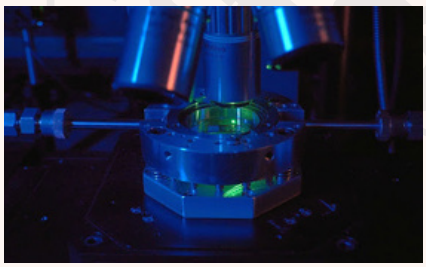
From Plastic To Power

Adina Muller ('25)

Everyday nearly 8 million pieces of garbage make their way into the oceans. Our world today produces about 380 million tons of plastic waste yearly! Scientists predict this number will double by the year 2034. But what if there was a way to make something useful out of all this waste?

In a recent study, researchers at Rice University in Houston, Texas, have discovered a new chemical process that can produce hydrogen from plastic wastes without the repercussions of releasing too much carbon dioxide into the environment or being too costly. This new method of creating hydrogen is called Flash Joule heating. The process works as follows; the scientists place a piece of plastic waste under a flaming hot beam for a total of four seconds, bringing the plastic waste up to a very high temperature of 3,100 degrees Kelvin which is about 5,120 degrees Fahrenheit. All this heat on the plastic allows the hydrogen to rise from within the plastic polymers and leave behind a thin layer of carbon atoms called graphene.

Aside from this newly developed process, the most common way for producing hydrogen today is done by a method called steam methane reforming. This process uses steam to react with methane (a natural gas), creating hydrogen and carbon dioxide as by products. The problem with this process is that it releases a significant amount of carbon dioxide to the atmosphere. This carbon dioxide is considered to be a greenhouse gas which is detrimental for the planet and contributes to heavy pollution.



The Flash Joule heating method brings plastic waste to a very high temperature.

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Air Shots: Revolutionizing Vaccines with Needle-Free Precision

Mikaella Inzlicht ('24)

As much as 15% percent of the population finds the idea of needles or looking at needles uncomfortable. Tyranaphbia, a fear of needles, is a serious condition which scientists are attempting to resolve. Their current approaches include vaccines designed in the form of pills, and most recently, the innovation of vaccines in the form of a puff of air.

The technology involves using a puff of carbon dioxide (CO2) to deliver tiny vaccine particles wrapped in metallic crystals through the skin. The strong crystal coating eliminates the need for refrigeration during storage. Once inside the body, the CO2 mixes with water, creating a weak acid that dissolves the crystal shield. This process releases the vaccine particles, allowing them to enter the bloodstream. Researchers have commented, based on self-experimentation, that it feels like being hit by a Nerf gun. "I could feel it, but it wasn't painful," commented one researcher. The inspiration for this new device came from "gene guns" used in agriculture, which shoot DNA directly into crops, temporarily instructing plants to exhibit specific behaviors, such as delaying fruiting in anticipation of frost.

The gas-based drug-delivery system is an improved alternative to previous models, offering customization of drug release speed by adjusting the carrying gas. Carbon dioxide was found to release drugs the fastest, while plain air led to a slower, gentler release. The system, demonstrated by Yalini Wijesundara, utilizes zinc instead of expensive metals, making it cost-effective. Tests involved delivering proteins into mice to observe how medicines behave in the body. While this system shows promise, challenges remain before it can replace needles, including concerns about splashback and potential scarring. Scarring happens because the scientists have noticed that some metal residue remained in the skin.

This new biological technology could have applications beyond human medicine, including possible use in livestock vaccines. Despite hurdles, the system aims to address needle-related fears, providing an optimistic outlook for broader vaccine adoption.

This article is adapted from: Carpenter, Katie Grace. "A Puff of Air Could Deliver Vaccines Needle-Free." Science News Explores, 18 September. 2023, https://www.snexplores.org/article/innovation-2023-needle-free-vaccine-air-puff-delivery

From Plastic to Power (Continued from page 1)

James Tour, a material-scientist, predicts that the demand for hydrogen in the coming years will "likely sky-rocket" and therefore the conventional way of creating hydrogen will not be sufficient, if scientists want to reach their set goal of reaching net-zero emissions by the year 2050.

As technology advances, the need for hydrogen will rise and therefore the Flash Joule heating method is very significant as it will enable scientists to supply the demand for hydrogen in a cheaper, more efficient, and better-for-the-planet way.

This article is adapted from:
"Making hydrogen from waste plastic could pay for itself." NSF: US National Science Foundation, 14 November. 2023, https://new.nsf.gov/news/making-hydrogen-waste-plastic-could-pay-itself

Fail Fast, Learn Faster

Malka Rosenholtz ('25)

"Just beautiful!" are the words SpaceX Engineers used to describe their (not first! but) second failed launch of the Starship space rocket. Why this is indeed beautiful may be an enigma to most, but in Elon Musk's company the mantra "Fail fast, learn faster" reigns supreme. Learning from failures and avoiding them in the future is considered progress. In this November attempt, Starship successfully fired all 33 booster engines, in direct contrast to the first Starship launch when the boosters failed, and fires broke out. This attempt also saw the rocket travel almost 90 miles above Earth. It was only while the stage separation was in the midst of being applauded by cheering crowds that all 33 suddenly exploded (thankfully sparing any damage to life or property). (Stage separation is where the boosters are meant to separate from the upper part of the rocket and drop into the water – in this case the Gulf of Mexico – to cool down and then be retrieved for reuse). A few short minutes later after the explosion of the boosters, all contact with Starship was lost. This ended SpaceX's second attempt at their elusive goal of having Starship travel around the world, and splash land in the Pacific Ocean.

As an aside, we cannot help but note that in this instance, SpaceX echoes the Jewish theme of *"Sheva yipol tzadik v'kum*". The emphasis on "getting up" after the failure, flips the failure into a stepping stone to success.

The ultimate success for Starship is to create many reusable Starships that can function both as Lunar landing machines as well as tankers and "orbital gas stations". This would allow for heavy loads of equipment as well as people to be shipped to the moon by refueling spacecraft in outer space (mid-flight!). Of course, pumping gallons of methane and liquid oxygen in zero gravity as well as keeping the fuel at steady temperatures as it orbits the earth closer and further from the Sun, represent some major challenges. But with Space X failing fast and learning even faster, these should all be overcome quickly.

Adam Davis/EPA,
via Shutterstock

The Super Heavy booster exploded soon after separating while the Starship vehicle continued flying into space. It, too, detonated several minutes into its flight.

The Space X definition of success has even made its way to NASA. "Each test represents a step closer to putting the first woman on the Moon with the #Artemis III Starship human landing system," said Jim Free, NASA's associate administrator for exploration systems development. NASA has contracted SpaceX as part of its Artemis Program to treat the moon as a base for even more deep space exploration, starting with landing two astronauts on the moon in late 2025. SpaceX is also expected to provide a Starship lander for another manned lunar trip, scheduled for 2028.

As much as NASA is celebrating the avoidance of failure at SpaceX, they are hedging their bets for Artemis by contracting with Amazon's Blue Origin for another lunar lander (just in case).

For more in depth coverage on Artemis, see MHS Labyrinth submission by Malka Rosenholtz.

This article is adapted from:
Chang, Kenneth. "SpaceX Starship Launch: Highlights From the 2nd Flight of Elon Musk's Moon and Mars Rocket" The New York Times, 18 November. 2023,
https://www.nytimes.com/live/2023/11/18/science/spacex-starship-launch-elon-musk

3D Printing Robots

Adina Altusky ('25)

Researchers at ETH Zurich and a US start-up have developed a new 3D printing technology that allows them to print soft robotic structures with bones, ligaments, and tendons made of different polymers.The term polymer refers to a chemical compound that consists of monomers which have been joined in a long chain. Polymers are strong, durable, and sustainable which is why they are found in plastic toys, rubber bands and many more objects which are used daily.

Thus far, the 3D printing technology was limited to creating fast-curing plastics. Researchers have now found a novel way to print Slow-Curing plastics. The fast-curing plastics that are most commonly used are types of plastic materials that harden or solidify relatively quickly when they are exposed to a specific trigger, often heat or light. When this type of plastic is used to 3D print, each layer quickly hardens allowing the next layer to be printed. It is true that this plastic is the faster method, however it does not permit flexibility and has many limitations when it comes to mechanical properties due to its hardness.

Because of the limitations of fast-curing plastics, researchers have developed a new way to 3D print robots, using Slow-Curing plastics. Slow-Curing plastic is a type of plastic that takes more time to harden or solidify compared to regular, fast-curing plastics. When you use Slow-Curing plastics in processes like 3D printing, it means that the material doesn't harden as quickly, allowing for more flexibility in the printing process.

3D printed in one go: A robotic hand made of varyingly rigid and elastic polymers. (Photograph: ETH Zurich/Thomas Buchner)

The materials have good elastic properties and can return to their original shape faster after bending. This makes them suitable for creating more durable and flexible robotic structures.

However, the scientists ran into a problem. With fast-curing plastics, a scraping tool is used to fix any bumps or uneven parts after each layer has been printed . This does not work with the Slow-Curing plastics. So they added a special laser scanner to check each layer for bumps right after it was printed. If the scanner found any problems, a smart system immediately adjusted how much material to use for the next layer. This technology allowed the machine to find and fix the problem immediately, instead of waiting till after the 3D process was over. This makes it more efficient to use Slow-Curing plastics.
By using this technology, scientists will be able to develop robots that will be capable of working with people or delicate items in a much safer fashion. Due to this advancement, robotics can now take on a wider range of possibilities.

This article is adapted from:
"Printed robots with bones, ligaments, and tendons" Science Daily, 15 November. 2023,
https://www.sciencedaily.com/releases/2023/11/231115113428.htm