LIMITLESS LIQUIDITY

To make sure that plants growing in huge greenhouse tunnels like these in Valencia, Spain, thrive optimally, they are continually irrigated. The hoses needed for this purpose must be regularly cleaned so that they don't clog up. Hydrogen peroxide (H_2O_2) is an especially environmentally friendly cleaning agent, whose only byproduct is water. Even so, for a long time it was seldom used in greenhouses because of the high costs of transportation and storage. The startup HPNow, in which Evonik has held shares since 2017, has found a way to avoid this dilemma: a modular generator that produces H_2O_2 electrochemically, directly on site and whenever it's needed.

A LOOK AROUND THE WORLD

Innovations from science and research

Secure Power for Space

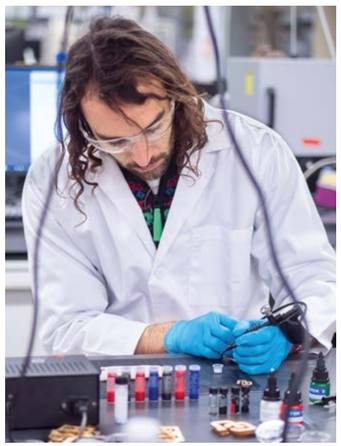
Researchers in the USA want to use chemical reactions to make the energy supply on space missions more reliable

Lots of energy is needed on space missions. This demand is normally covered by solar power, which, however, has a major drawback: Because it depends on the intensity of the sun's radiation, it is not always reliably available. That's why a research team at the University of Central Florida (UCF) is working on a backup system that provides energy using chemical reactions and is thus always available. A compound of silicon and at least one other element is burned slowly as oxygen is added. The energy generated can be easily stored and supplies heat and electricity even in very cold environments.

In the future, this technology might not only benefit space missions but also form the basis for the energy supply of space colonies. The National Aeronautics and Space Administration (NASA) considers this idea to have great potential and has been providing the project with $550,000 of funding since last year.

PEOPLE & VISION

"This tattoo helps protect skin against the sun's rays"



THE MAN

Carson Bruns never really wanted to choose between art and scientific research. When he ate at the dining room table during his childhood in Colorado, he sometimes mixed food such as tomato sauce and juice together and observed how the mixture's color changed—his investigative spirit had been awakened. Later, as a teenager, he took up painting. Art continued to be a part of his life even after he began to conduct research professionally, especially in chemistry. Bruns, 34, is now an assistant professor at the University of Colorado and works in a field, tattooing, that combines both of his big passions.

THE VISION

Carson Bruns has developed a tattoo that serves as a UV sensor for the skin. This tattoo turns blue when human skin is exposed to ultraviolet radiation. This effect is created by microcapsules that contain pigment. The color change notifies the tattoo's wearer that his or her skin should be better protected, and so helps prevent long-term damage such as skin cancer. Although the sun-protection tattoo is still at the testing stage, Bruns is already thinking a step further: He is working on a tattoo that would not only warn of UV radiation but also actively protect the skin against it.

A Botanical Stress Test

Plants have a special protective mechanism that enables them to survive in emergency situations: If they are attacked or are damaged by environmental factors, the plants supply the cells in their leaves with hydrogen peroxide (H_2O_2). It acts as a kind of alarm signal, which causes the cells to quickly produce chemical compounds that repel enemies such as insects and snails as well as repair damage.

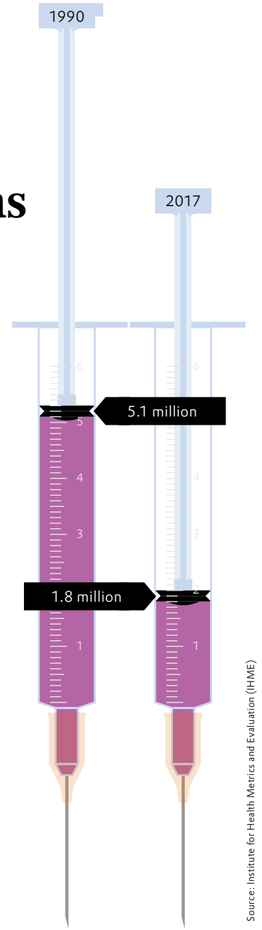
In order to better understand how this effective early warning system works in nature, engineers at MIT in Boston have developed special sensors made of carbon nanotubes. The sensors are embedded in leaves, where they can register the H_2O_2 alarm signals and precisely determine how different types of plants react to stress factors such as injury, infection, and damage caused by light.

The results are especially interesting for agriculture. On the basis of this data, agronomists will be able to develop strategies for helping cultivated plants deal with stress and in this way optimize crop yields.

THAT'S BETTER

Life-saving Injections

Over the past 30 years, the child mortality rate has declined by almost two thirds worldwide. Vaccines play a key role here. Whereas 5.1 million children still died of vaccinable diseases in 1990, this figure had declined to 1.8 million lately. This progress is mainly due to the vaccines DTP against diphtheria, tetanus, and pertussis (whooping cough), and MMR against measles, mumps, and rubella. By contrast, the drop in mortality was much less pronounced for diseases against which there are no vaccines.



Source: Institute for Health Metrics and Evaluation (IHME)

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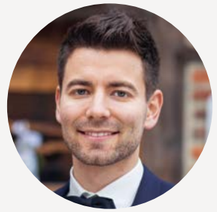
PERCENT

is the annual growth rate of the 3D printing material market until 2024, according to a forecast made by the Research and Markets institute. The medical sector in particular—which uses these materials to make implants, for example—is a key driver of this development.

AUTONOMOUS HEALING

As the corona crisis shows, interrupted supply chains can sometimes cause supply bottlenecks. This carries especially high risks in the case of medications. Researchers at the Max Planck Institute of Colloids and Interfaces in Potsdam have found a possible solution to this problem: It consists of an autonomous, computer-controlled laboratory that can quickly and locally produce organic substances such as raw materials for medicine.

GOOD QUESTION



"Mr. Sandfort, will AI be able to predict the results of chemical reactions in the future?"

Yes, it will be able to do so if the data permits. Chemical reactions depend on a variety of factors. It's hard to predict how effective they will be, which leads to many experiments, including "unnecessary" ones, being carried out. My colleagues and I have therefore developed an AI model that's based on machine learning. From a myriad of experimental arrangements, it filters out those that are most likely to work. Artificial intelligence can, for example, select an optimal catalyst. Until now, researchers have first had to create and test a whole series of catalysts. In addition, AI can predict the selectivities, i.e. the proportions of the desired material in the end product, as well as the yields—the amounts of products. This model is currently limited to a few applications. In order to change that, we need more suitable data and a combination of AI and robotics.

Frederik Sandfort, a doctoral student at the Institute of Organic Chemistry at the University of Münster, is one of the authors of the study titled "A Structure-Based Platform for Predicting Chemical Reactivity."