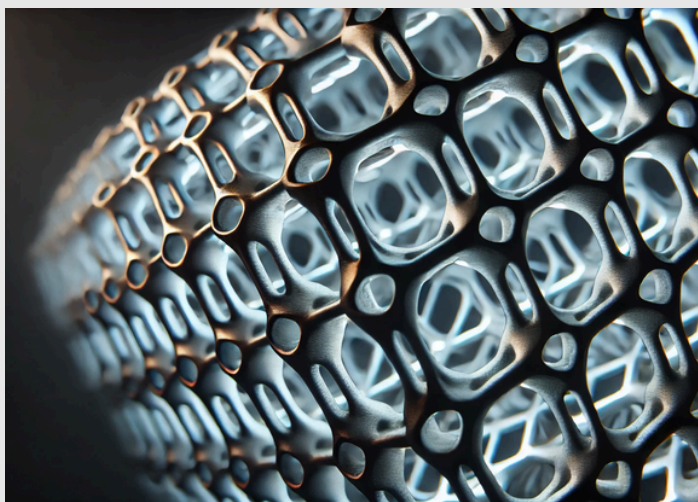




SPARC WEEKLY



REIMAGINING CHAIN MAIL: 3D ARCHITECTED MATERIALS THAT ADAPT AND PROTECT



Experiments have yielded a fascinating new type of matter, neither granular nor crystalline, that responds to some stresses as a fluid would and to others like a solid. The new material, known as PAM (for polycatenated architected materials) could have uses in areas ranging from helmets and other protective gear to biomedical devices and robotics.

PAMs are not found in nature, though their basic form is known to us through the millennia-old manufacture of chain mail: small metal rings linked together to form a mesh, most often used as a flexible form of armor.

PAMs, however, are like chain mail on steroids. Following the basic principle of interlocking shapes, like those found in a chain,

PAMs are made up of a variety of shapes linked together to form three-dimensional patterns whose configurations are almost unimaginably variable. The resulting materials, which scientists have rendered using 3D printers, exhibit behaviors not found in other types of materials.

The PAMs that Caltech lab of Chiara Daraio's group created and studied were first modeled on a computer and were designed to replicate lattice structures found in crystalline substances but with the crystal's fixed particles replaced by entangled rings or cages with multiple sides. These lattices were then printed out three-dimensionally using a variety of materials, including acrylic polymers, nylon, and metals. Once the PAMs could be held in the palm of one's hand they were exposed to various types of physical stress. In some scenarios, these PAMs behaved like liquids. But when these structures are compressed, they may become fully rigid, behaving like solids. This dynamism makes PAMs unique and a new type of matter.

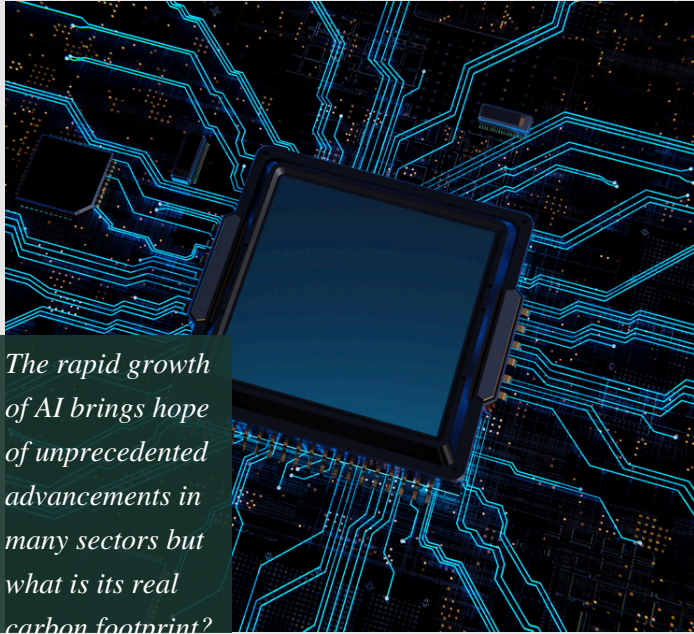
Experiments have shown that they will expand or contract in response to applied electrical charges as well as physical forces, suggesting possible uses in biomedical devices or soft robotics.

<https://www.sciencedaily.com/releases/2025/01/250121162100.htm>

<https://www.youtube.com/watch?v=Z-P7lfW-p-8>

<https://www.caltech.edu/about/news/reimagining-chain-mail>

CALCULATING THE TRUE ENVIRONMENTAL COSTS OF AI



Artificial intelligence (AI) is taking the world by storm, growing not only in the number of available systems but also in complexity and ability. To fuel this expansion, a monumental amount of energy is needed to meet the increasing demand for computing power.

But at what environmental cost?

While it's no secret that AI has a significant environmental footprint, especially considering the energy consumption of data centers that are continuously powered and require extensive cooling, pinpointing its true carbon impact has been challenging. The lack of a standardized method for measurement makes it difficult to quantify the exact impact of AI's energy demands.

With AI expected to grow by 30-40% annually over the next decade, it is clear this technology is here to stay and will only get

bigger. "A few studies have estimated the carbon footprint of individual AI systems, like GPT-3, especially after it became popular," said Meng Zhang, a researcher at Zhejiang University in China. However, very few have attempted to calculate the combined emissions the world's major AI systems to understand their collective footprint.

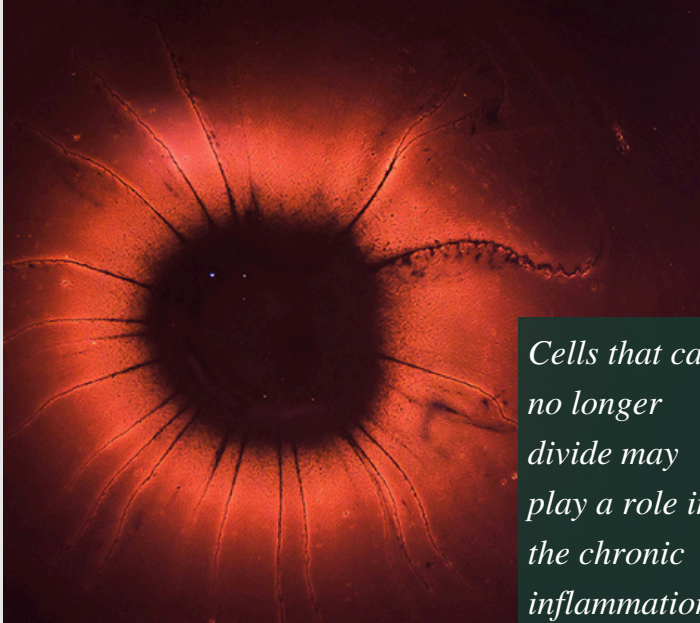
In their study, Zhang and his team calculated the carbon emissions emitted between 2020 and 2024 from 79 well-known AI systems, including Gemini Ultra, GPT-4, Mistral Large, and Inflection-2. What they found was that collectively, the top 20 AI systems they included in their study consumed enough energy to rival a small country, like Iceland or Democratic People's Republic of Korea as examples. In fact, in 2022, the carbon emissions from these AI systems surpassed the emissions emitted by 137 individual countries. The team also predicted that the projected total carbon footprint from the AI systems could reach up to 102.6 Mt of CO₂ equivalent per year — similar to the emissions from 22 million people over the course of a year.

This could potentially have a substantial impact on the environmental market, exceeding \$10 billion annually, especially considering potential carbon penalties in the near future.

One thing is certain: AI is here to stay, and that's not necessarily a bad thing given the benefits it brings to society. Like any technology, it has its pros and cons.

<https://www.advancedsciencenews.com/calculating-the-true-environmental-costs-of-ai/>
<https://link.springer.com/article/10.1007/s11783-024-1918-y>

STUDY FINDS ZOMBIE CELLS MAY PLAY A ROLE IN AGING



Cells that can no longer divide may play a role in the chronic inflammation

New research suggests that “zombie cells” may contribute to age-related chronic inflammation. This finding could help scientists understand more about the aging process and why the immune system becomes less effective as we get older.

Zombie or “senescent” cells are damaged cells that can no longer divide and grow like normal cells. Scientists think that these cells can contribute to chronic health problems when they accumulate in the body. In younger people, the immune system is more effective at clearing senescent cells from the body through a process called apoptosis, but as we age this process becomes less efficient. Earlier research has found that these zombie cells can induce the zombie state in nearby cells. Zombie cells don’t divide, but they continue to use energy and can secrete chemicals that cause inflammation. Though inflammation is the body’s normal short-term response to injury

or illness, inflammation that persists for longer periods of time can damage healthy cells and contribute to the development of chronic diseases.

Aging is linked to immune dysregulation and one of the key features is inflammaging.

Inflammaging is a term used to describe the low-grade, chronic inflammation that develops in older people and is a significant risk factor for age-related conditions such as kidney and heart disease, diabetes, cancer, and dementia. In their study, the researchers focused on tiny, membrane-bound structures called extracellular vesicles, which are naturally released from most types of cells. The chemicals carried by zombie extracellular vesicles are different from those carried by normal extracellular vesicles. These differences could help explain how zombie cells affect the immune system and contribute to the aging process. For example, the researchers found that immune cells were more likely to take up the extracellular vesicles released by zombie cells. When these immune cells were provoked with a molecule known to cause inflammation, they secreted larger amounts of a protein that regulates the inflammatory processes and is associated with certain inflammatory and autoimmune diseases.

Although preventing inflammaging is a promising strategy for reducing the incidence of chronic diseases and prolonging a healthy lifespan, more work is needed before scientists will be able to develop therapies that slow the aging process and make older people less susceptible to conditions like cancer, heart disease, and other age-related diseases.

<https://www.advancedsciencenews.com/study-finds-zombie-cells-may-play-a-role-in-aging/>

NEW WATER PURIFICATION TECHNOLOGY HELPS TURN SEAWATER INTO DRINKING WATER WITHOUT TONS OF CHEMICALS



Selective removal of trace contaminants from water remains a crucial challenge in water treatment.

Water desalination plants could replace expensive chemicals with new carbon cloth electrodes that remove boron from seawater, an important step of turning seawater into safe drinking water.

A study describing the new technology has been published in *Nature Water* by engineers at the University of Michigan and Rice University.

Boron is a natural component of seawater that becomes a toxic contaminant in drinking water when it sneaks through conventional filters for removing salts. Seawater's boron levels are around twice as high as the World Health Organization's most lenient limits for safe

drinking water, and five to 12 times higher than the tolerance of many agricultural plants.

In seawater, boron exists as electrically neutral boric acid, so it passes through reverse osmosis membranes that typically remove salt by repelling electrically charged atoms and molecules called ions. To get around this problem, desalination plants normally add a base to their treated water, which causes boric acid to become negatively charged. Another stage of reverse osmosis removes the newly charged boron, and the base is neutralized afterward by adding acid. Those extra treatment steps can be costly.

Scientists have developed a new technology that's fairly scalable and can remove boron in an energy-efficient way compared to some of the conventional technologies. The device reduces the chemical and energy demands of seawater desalination, significantly enhancing environmental sustainability and cutting costs by up to 15 percent, or around 20 cents per cubic meter of treated water.

Those kinds of savings could help make seawater a more accessible source of drinking water and alleviate the growing water crisis.

Freshwater supplies are expected to meet 40% of demand by 2030, according to a 2023 report from the Global Commission on the Economics of Water.

<https://www.sciencedaily.com/releases/2025/01/250121130053.htm>
<https://www.nature.com/articles/s44221-024-00362-y>

WHO ARE WE?

SPARC Robotics Team's mission and vision is to make our environment the best it can be. On a volunteer basis, we look at the problems that are happening around us and make them our problems, both as SPARC and individually, and help as much as we can with appropriate projects. NASA ACCP (Astro Camp Community Partners) was only in the US until four years ago. This year they came to Turkey with us after four years of traveling to many countries. ACCP educates school-age children from kindergarten to high school on science-related topics of interest with practical knowledge and application, while also supporting children's craft development, general culture and questioning skills. As SPARC, we have brought this training provided by NASA to our country in the most comprehensive way and our continuous communication with NASA not only enables us to improve our trainings day by day, but also gives us the opportunity to learn about the innovations in the field of STEM instantly, from the most accurate source and to spread the knowledge we have around us.



EDITOR

Dear reader,

Greetings from SPARC Weekly, in which we gather latest scientific news.

We would be delighted to hear your comments or suggestions and we encourage you to write to us if you have any views or opinions on the stories in SPARC Weekly. We look forward to hearing from you.

Have a nice week and enjoy the magazine.

Defne Şehidođlu and Reyhan Dođanca