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Genius loci...

Tisková zpráva

Czech scientists develop a material for producing chemicals from water and sunlight, inspired by human enzymes

Olomouc (January 15, 2026) - **The human body is the most sophisticated atomic engineer. This idea underpins a breakthrough technology developed by an international research team led by scientists from the Czech Advanced Technology and Research Institute (CATRIN) at Palacký University Olomouc and the Centre for Energy and Environmental Technologies (CEET) at VSB – Technical University of Ostrava. By drawing inspiration from the way enzymes function in the human body, the researchers have created a novel material that could fundamentally change the industrial production of hydrogen peroxide and other important chemicals. The new approach simplifies the production process, eliminates the need for toxic organic solvents and expensive precious metals, and requires only sunlight, oxygen and water to operate. The results were published by the prestigious journal Nature Communications, which ranked the study among the 50 most significant scientific discoveries of the year.**

Hydrogen peroxide is one of the most important industrial chemicals. It is widely used not only in the chemical industry but also in pharmaceuticals, medicine, the textile industry and water-treatment technologies. The global hydrogen peroxide market is estimated to exceed USD 5 billion annually. Conventional production involves a multistep process that relies on toxic organic solvents and costly palladium-based catalysts. In addition, both the starting chemicals and the resulting waste products can have negative impacts on human health and the environment.

“Our aim was to develop a material that enables the efficient, environmentally friendly and affordable production of hydrogen peroxide. When designing this photocatalyst, we were inspired by the structure and behaviour of enzymes in the human body. The result is a technology that does not require toxic organic solvents or expensive precious metals and instead uses a low-cost material based on carbon, nitrogen and copper. It operates in water using only sunlight and oxygen from the air,” said Radek Zbořil, leader of research teams at CATRIN and CEET.

In developing the new photocatalyst, the Czech scientists mimicked the function of cytochrome c oxidase—an enzyme that enables human cells to obtain energy by transferring electrons to oxygen. This process relies on copper atoms embedded in the enzyme’s structure, and it was precisely this mechanism that the researchers sought to reproduce.

“We very precisely replicated the chemical environment of metals within the enzyme’s structure and anchored copper atoms onto the surface of extremely small carbon nanoparticles with photocatalytic properties. When exposed to light, highly efficient electron transfer occurs between the carbon nanoparticles, the copper atoms and oxygen molecules. This process closely resembles

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an enzymatic reaction and enables high hydrogen peroxide production," explained the first author of the study, Lukáš Zdražil, who is affiliated with both CATRIN and CEET.

Producing hydrogen peroxide using sunlight and water has been a long-standing goal of research teams worldwide, as it eliminates the use of toxic organic solvents and avoids the formation of hazardous by-products. Until now, however, research in this area has largely remained at an academic level, mainly due to the use of noble metals and often complex photocatalyst designs. Laboratory studies have also resulted in relatively low hydrogen peroxide yields, which could not compete with existing industrial processes.

"The new photocatalyst achieves hydrogen peroxide production rates up to two orders of magnitude higher than all previously reported systems, bringing us much closer to industrial requirements. In addition, the material is completely non-toxic, easily recyclable and reusable," added Zdražil.

The Czech teams are now focusing on potential applications of this technology in decentralised production units. Such systems could enable efficient, local production of hydrogen peroxide, for example for use in agriculture, pharmaceutical manufacturing or environmental applications. The combination of solar energy and materials inspired by enzymatic systems may also lead to further promising advances.

"I believe that mimicking the structures and functions of iron- and copper-based enzymes could pave the way for other innovative technologies in the chemical industry and pharmaceuticals, such as the production of epoxides, alcohols or phenols," concluded Zbořil.

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