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LIKAT Researchers and APEX Develop a Hydrogen Battery

Chemists at the Leibniz Institute for Catalysis, LIKAT, together with the company APEX, developed a catalytic system that can chemically store hydrogen and release it in a highly pure form at will. On this basis, systems based on the principle of a battery could in the future donate hydrogen anytime and anywhere, e.g. to power fuel cells. Dr. Henrik Junge's research group published its findings in the specialist journal NATURE ENERGY, which also had a commentator rate the work as a highlight. Among other things, the paper reports about the "remarkable activity" of the catalyst and the "extraordinary" efficiency of the chemical reactions.

In fact, this work can take a good step forward in the global effort to replace oil and gas as energy raw materials and to use CO_2-neutral processes. After all, hydrogen is now accepted as the future basis for the energy sector, as Dr. Henrik Junge explains, but its storage is still problematic. Hydrogen is explosive in the presence of oxygen and, as a gas, is volatile and of low density under normal conditions, which is why leading research laboratories are primarily exploring chemical ways of storing it.

Formic Acid as a Storage Medium

Dr. Duo Wei, a postdoctoral researcher at LIKAT in Rostock, used formic acid and its salts, so-called formiates, as a storage medium for hydrogen. A year ago, the Rostock chemists described in the journal CHEMICAL SCIENCE how they catalytically store hydrogen in formiates using carbon dioxide from the air and the amino acid L-lysine . Dr. Junge: "Of course, it would be elegant if we could release the hydrogen again in the same system as needed to use it." That's exactly what the current work has accomplished.

The chemists developed the catalyst that enables all the necessary chemical reactions on the basis of a manganese complex, so it does not require a precious metal, unlike most hydrogenation processes to date. There are other advantages, as LIKAT director Prof. Dr. Matthias Beller explains. Normally, when hydrogen is recovered from formiates, the carbon dioxide used for storage is released again. "We, on the other hand, permanently retain the CO_2 in our reaction system." The trick is for the researchers to bind the CO_2 to a common amino acid that occurs in nature and in ourselves.

High Yields of 90 and 80 Percent Respectively

The newly developed reaction system follows the principle of an electric battery, with the difference that hydrogen is used instead of electric current. Such a battery is thus filled once at the beginning with CO_2 from the air. It can then go through the cycle of hydrogenation (H_2 storage) and dehydrogenation (H_2 release) several times, with new hydrogen always being loaded into the storage.

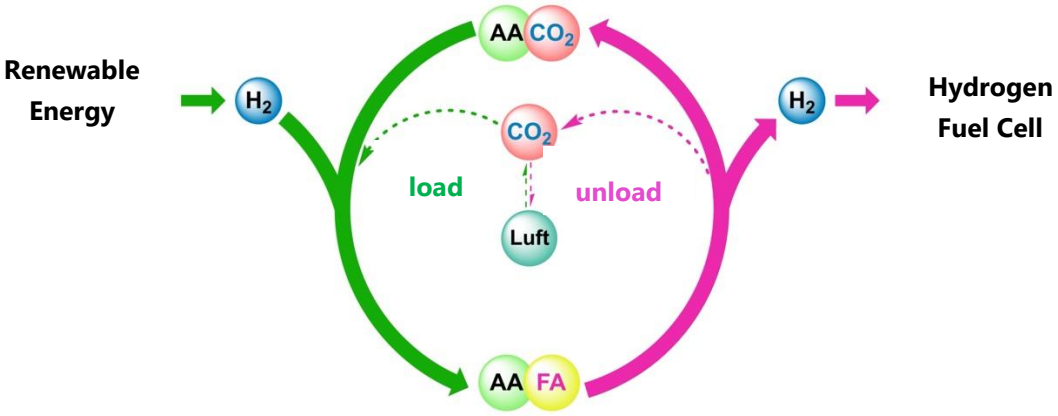

Fig: The hydrogen battery is based on carbon neutral chemical storage and release of H_2: CO_2, amino acid (AA) and H_2 are converted to formiate, the salt of formic acid (FA). The CO2 remains in the cycle (bold arrows), which has advantages over CO_2 recycling (dotted arrows). Graphic: LIKAT

Among other things, the high yields of this process - more than 90 percent for H_2 storage and 80 percent H_2 release - highlighted a commentary with which the journal NATURE ENERGY, usually has such groundbreaking developments evaluated. Commentator Sheri Lense was impressed by the "remarkable activity" of the catalyst and an "exceptionally high total TON" (turnover number) even after ten charge cycles.

In the future, a process on this basis will develop its full charm above all when the hydrogen to be stored comes from renewable sources in the region, such as wind power or photovoltaics. Henrik Junge: "Such sources do not gush forth continuously. That's why the green-based hydrogen economy needs large storage capacities, preferably of a chemical nature, also locally on site."

Patent Application with APEX Group

All of this is basic research, as Dr. Junge emphasizes, but it is highly suitable for helping to transform the economy and the energy sector with climate-neutral processes. In addition, chemistry is increasingly recognizing carbon dioxide in the atmosphere as a source of raw materials, starting material for a wide range of useful products, as Henrik Junge says.

LIKAT's cooperation with the APEX Group will ensure that their findings are put to practical use. Dr. Peter Sponholz, head of research and development at APEX is one of the five-member team of authors of the NATURE ENERGY paper. The application for a joint patent filed by APEX is currently underway.

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