Transforming hydrogen into liquid fuel using atmospheric CO2

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Swiss scientists have completed their solution for transforming hydrogen gas into a less flammable liquid fuel that can be safely stored and transported. Another possible application of their technology would be to use atmospheric CO2to synthesize a number of useful chemical products.

Hydrogen is often touted as the fuel of the future. But because this gas is highly explosive, it must be stored and transported under pressure in specialized and expensive containers. Hydrogen therefore has issues in terms of safety, logistics, and profitability that could significantly limit its wider use. However, a solution might lie in research by EPFL scientists, who have developed a simple system based on two chemical

reactions. The first reaction transforms hydrogen into formic acid, a liquid that is easy to store and less flammable than gasoline, while the second reaction does the reverse and restores the hydrogen. Another possible application of their technology would be to use atmospheric CO2 to synthesize a number of useful chemical products.

Gabor Laurenczy's team has already developed a process for transforming formic acid into hydrogen gas. The method was the subject of several articles, one of which appeared in *Science*, and it is currently under industrial development. But a complete and coherent system would also require the inverse process: transforming hydrogen into formic acid. This has now been achieved, completing the cycle, thanks to the financial support of EOS Holding. The scientists in Laurenczy's team have described the process in a *Nature Communications* article.

The researchers synthesized formic acid in a single step, starting with hydrogen and atmospheric CO2. Conventional methods to accomplish this involve several steps, which are complicated to carry out and generate undesirable chemical byproducts.

The two chemical reactions – hydrogen to formic acid and back to hydrogen - are catalytic: the advantage is that nothing is lost in the transformation, and the process can thus be used in constructing sustainable devices.

With their two catalytic reactions, the researchers now possess all the technology they need to build a complete, integrated device. Laurenczy envisions small energy storage units in which the current from photovoltaic cells produces hydrogen by electrolysis, which is then transformed and stored as formic acid, and finally transformed back into hydrogen to produce electricity at night-time. "Our procedure is simple enough that it can be implemented at the domestic level," he says.

Another possible application of this technology would be to use atmospheric CO2, a greenhouse gas, as a building-block for chemical synthesis. Formic acid is the basis of numerous organic syntheses, e.g. in the textile industry. As Laurenczy explains: "We are killing two birds with one stone: we could sequester part of the 35 gigatons of CO2 that are emitted into the atmosphere every year, and also use it to synthesize materials."

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