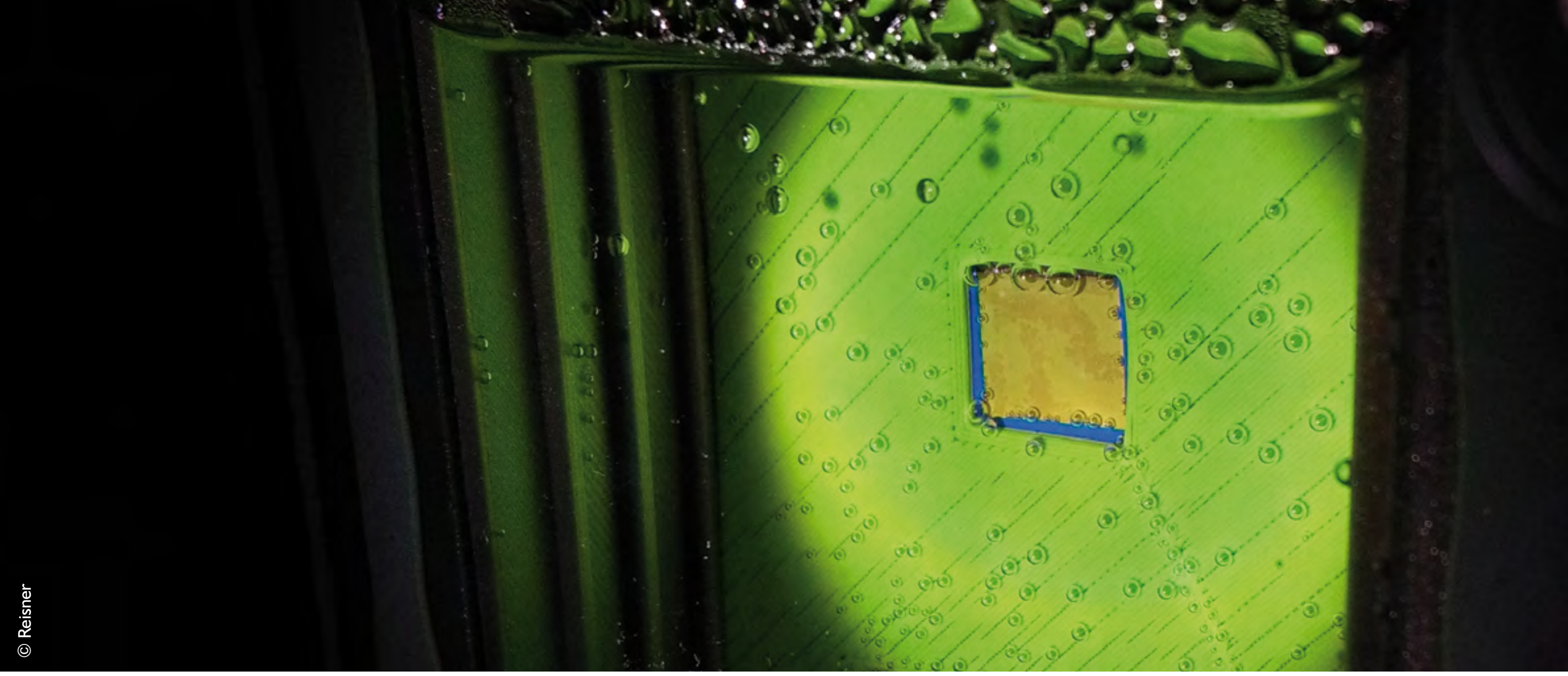
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Federal Ministry
Republic of Austria
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Christian Doppler
Forschungsgesellschaft

Solar SynGas: Sustainable fuels are possible

Oil, gas, coal: almost 80% of the energy we use today comes from burning fossil fuels. A Christian Doppler Laboratory is paving the way for climate-neutral fuels based on the example of photosynthesis.

The topic

When asked about sustainable energy, many people first think of windmills and solar cells, in other words of electricity. But it is also possible to produce fuels in a climate-neutral way. The way plants carry out photosynthesis provides a good model: with the help of sunlight, sustainable syngas can be produced from CO_2 and water – and subsequently converted to all of the products that normally come from crude oil. Burning the fuels releases no more CO_2 than the amount that was bound when they were produced. The fuels could be used with existing systems (cars, airplanes, heating equipment), which as a result would no longer damage the climate.

The research question

The biochemistry of photosynthesis has been well studied. CO_2 and water are used to produce sugar, with oxygen as a by-product – and the necessary energy comes from the sun. The process is complex and takes place via a number of intermediate steps. Chlorophyll

CD Laboratory for Sustainable Syngas Chemistry

Head
Prof. Erwin Reisner; University of Cambridge

Operation
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Commercial partner
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Thematic cluster
Chemistry

Three questions to ...

Prof. Erwin Reisner
Head of the CD Laboratory for Sustainable Syngas Chemistry at the University of Cambridge

Why does working with companies help advance basic research? The interaction with companies gives us access to new questions and this can hugely enrich basic research. On top of that, it is important to collaborate when fundamentally new knowledge or concepts are being developed that may be relevant for application in the energy sector. Collaboration with industry will be absolutely necessary for the ideas to be applied.

What are the biggest challenges in collaborating with companies? Professors can afford to plan very long-term to tackle the really big questions that we are facing. But companies are subject to short-term business cycles, relatively quick turnover in staff and other external pressures, so their strategic priorities may change at a short notice. This can bring challenges to engage in a long-term collaboration that does not rely on short-term outcomes.

What do you like most about the CD Laboratory funding scheme? Although I was a young group leader, the CD Laboratory enabled me to pursue an idea for many years and ultimately to prove that it works and to produce a prototype. In addition, the Lab was a huge benefit to the careers of a large number of junior scientists, not only mine but also those of the many members of the CD Laboratory's staff who are now heading their own research groups. And last but not least it represented the start of my collaboration with industry.

has an essential role in absorbing light, enzymes enable and promote the reaction and the correct spatial organization is important.

What functions in nature can in principal be made to work in the laboratory, so the CD Laboratory for Sustainable Syngas Chemistry took the process as its model. Of course, the Lab aimed to produce not sugar but synthetic gas, or syngas for short. This mixture of hydrogen (H_2) and carbon monoxide (CO) is currently produced in megaton quantities from fossil fuels – so not sustainably – and forms the starting material for numerous products of the petrochemical industry, such as plastics, fertilizers and medicines. If syngas could be generated sustainably along the lines of photosynthesis, it could be used to produce a sustainable fuel.

The work of the CD Laboratory

The scientists in the CD Laboratory for Syngas Chemistry were faced with two major challenges. Which materials would make suitable catalysts, able to kick-start the reaction and so take on the role of the photosynthetic enzymes? The group undertook a very detailed study of these enzymes and was then able to synthesize cheap and stable molecules with comparable properties: newly developed molecular catalysts to generate carbon monoxide from carbon dioxide and to make hydrogen from water.

The second key question related to the materials that absorb sunlight and the surfaces on which the catalysts should be arranged. Which materials would be suitable and how should the catalysts be arranged on them so that the sun's energy can be taken up and used as efficiently as possible?

Results: yes we can

After seven years of work in the CD Laboratory, Prof. Reisner and his team were able to show that the idea really works. There is a prototype in Cambridge that can be described as an "artificial leaf". It is a few millimetres thick, several square centimetres big, made up of numerous layers and completely immersed in water. When exposed to sunlight at room temperature it makes syngas from water and CO_2, with oxygen as a by-product – exactly as in photosynthesis. This discovery has enabled the CD Laboratory to make new catalysts to convert organic and plastic waste for use by the petrochemical industry.

Visions for science and the economy

The research is still in its infancy. The prototype is small and expensive, it has only a short operation time and does not use solar energy very efficiently. Whether and when genuine alternatives to fossil fuels can be produced will depend to a large extent on the political will and the engagement of countries and companies, as Reisner is keen to stress. However, if the appropriate efforts are made, it should be possible to move from fossil fuels to sustainable fuels by 2050

Application-oriented basic research and innovation

By participating in a CD Laboratory, companies are investing in genuine innovation. Basic research breaks new scientific ground and its results represent a knowledge advantage that can be decisive in competition with other firms. Unexpected results from basic research may play an important part. As an example, patented catalysts for the solar-powered conversion of organic and plastic waste into basic chemicals for the petrochemical industry were a "by-product" of the research in the CD Laboratory. They can facilitate waste reduction and enable new products to be made with the release of much less CO_2 than at present.

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