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Plants have exquisite mechanisms for turning light into other forms of energy and harvesting carbon dioxide from the air.

Sweeter energy, inspired by photosynthesis

Scientists have found a way to combine the principles of photosynthesis – the conversion of carbon dioxide and sunlight into oxygen, water and sugar – with their own technological wizardry.

The result is 'artificial photosynthesis', a process that may one day help reduce greenhouse gases and provide clean energy and an alternative source of fuel.

'Issues of fuel, clean energy and greenhouse gases are tackled constantly all around us by plants,' project leader, Dr Vijoleta Braach-Maksvytis says.

'They have exquisite mechanisms for turning light into other forms of energy and for harvesting carbon dioxide from the air. So nature is a good place to start looking for answers to our environmental problems.'

Rather than trying to recreate a plant in the laboratory, Braach-Maksvytis and her colleagues from CSIRO Telecommunication and Industrial Physics incorporated the principles of photosynthesis into the construction of their own tiny energy and fuel production systems.

Following nature's lead, the team began by piecing together an artificial membrane, replicating part of the complex photosynthetic structure housed in the chloroplasts of leaf cells. To do this they used a process called 'self-assembly'.

'Nature's manufacturing process is called self-assembly. It builds from the bottom up, atom by atom, molecule by molecule,' Braach-Maksvytis says.

'By designing the molecular components of a structure correctly, we can get them to self-assemble into the structure we want when they are combined in a test tube.'

Using the same technique, the team then embedded a light-sensitive bacterial protein into the artificial membrane, to mimic the function of chlorophyll and other leaf pigments.

In the leaf, these pigments ferry light energy, in the form of electrons, around the chloroplast, creating an electrical potential that can be measured.

When Braach-Maksvytis and her team attached an electrode to their membrane-protein structure, they were also able to measure a current, indicating the protein had been successfully inserted into the artificial membrane.

The result is the first step towards making a multi-layer membrane structure, in which each layer contains different elements that form part of an electron cascade, and that work together to produce clean energy. While many of these elements may be biological, Braach-Maksvytis says the team is not restricted to all-natural ingredients.

'We're striving to make a multi-layer structure that uses elements modified from plants, but also from our technology. For example, we're looking at the principle of electron transfer, so we're after a material that can move electrons around. Semi-conductor particles such as titanium dioxide could perform that function.'

While the work is being conducted at the nano level (the artificial membrane is only 30 nm in size), Braach-Maksvytis says the concept may eventually be scaled up to address our environmental problems.

In addition to the artificial membrane work, the team has been developing the second principle of photosynthesis – converting carbon dioxide to fuel – by bubbling the gas over the surface of an electrode to produce methane.

'By-products of the process could be a valuable alternative fuel, even food in the form of starches and sugars,' Braach-Maksvytis says.

Both projects are still in the early stages of development, but Braach-Maksvytis says it is important that we start dealing with our environmental problems now.

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