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Cutting green hydrogen costs by putting electrons in order

By **Stephen B. Harrison** on Aug 11, 2025

In green hydrogen production, electricity costs can account for up to 70% of the levelised cost of hydrogen (LCOH). Yet many alkaline and PEM electrolysers still lose around 30% of their input power as heat.

Improvements are being made to existing technologies. However, Israeli start-up Chiral Energy is taking inspiration from nature's own molecular design – chirality – to align electron spin, reduce energy waste, and cut LCOH.

Hand-in-hand with chirality

"A left glove and a right glove are mirror images, but you can't put the left glove on your right hand comfortably", said Nir Marom, CEO of Chiral Energy. Chirality describes molecules that have the same atoms arranged in the same way but exist in two non-superimposable mirror-image forms – like left and right hands.

In nature, many molecules, such as sugars, DNA, and proteins, are chiral, but living systems tend to produce only one "handedness" for each. That selectivity isn't by chance. It helps align the spin of electrons, improving the efficiency of processes like photosynthesis and cellular respiration.

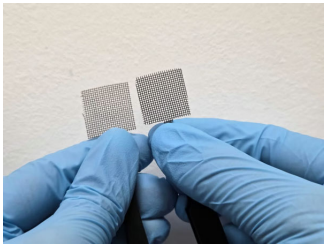
And that is exactly what Chiral Energy is attempting to exploit.

The company's founding members researched how nature uses chirality to its advantage. And they have used their insights to improve electrochemical processes which are being industrialised today, such as fuel cells, batteries, and hydrogen electrolysers.

"Aligning the direction of spin of electrons is the key to efficient electrolysis. And it has its roots in energy-efficient bio-processes," Marom said.

Less friction, more efficiency

Electrochemical processes rely on the transfer of electrons. When electron spins are random, their movement is chaotic – like a hundred cows trying to cross a narrow bridge at the same time. But order the cows in single file and they cross quickly without blockages.



Uncoated and chiral-coated electrolyser electrodes © Chiral Energy

Marom said, "Creating an orderly flow of electrons can be achieved by Chirality-Induced Spin Selectivity, or the 'CISS' effect.

"This is a phenomenon where the chirality of a molecule influences the spin of electrons that pass through it. Nature uses one-sided chiral molecules so that all the electrons pass with the same aligned spin."

If a chiral molecule is applied to the electrolyser electrode, the spin of the electrons flowing through the electrode is systematically aligned, and they flow smoothly with less friction.

The result is less wasted energy and a more efficient conversion of electricity to hydrogen. Fuel cells can similarly benefit from the CISS effect to improve their efficiency of fuel gas to power generation.

'Turbo-charging' catalysts

In PEM and alkaline electrolysers, catalysts are used to reduce the amount of energy that is required to split water into oxygen and hydrogen. Electrolyser OEMs and electrode component producers have developed proprietary catalyst formulations that split water with maximum efficiency and maximise the operational life of the electrode.

In PEM electrolysers and fuel cells, the use of platinum group metals (PGMs) is common. In alkaline electrolysers, PGMs can be used to enhance the catalytic effect of nickel, an earth-abundant metal.

Chiral Energy's nano-structured coating is an additional layer that works with, not instead of, existing catalysts. The catalyst layer is the narrow bridge; the Chiral coating is the system organising the cows into line before they cross.

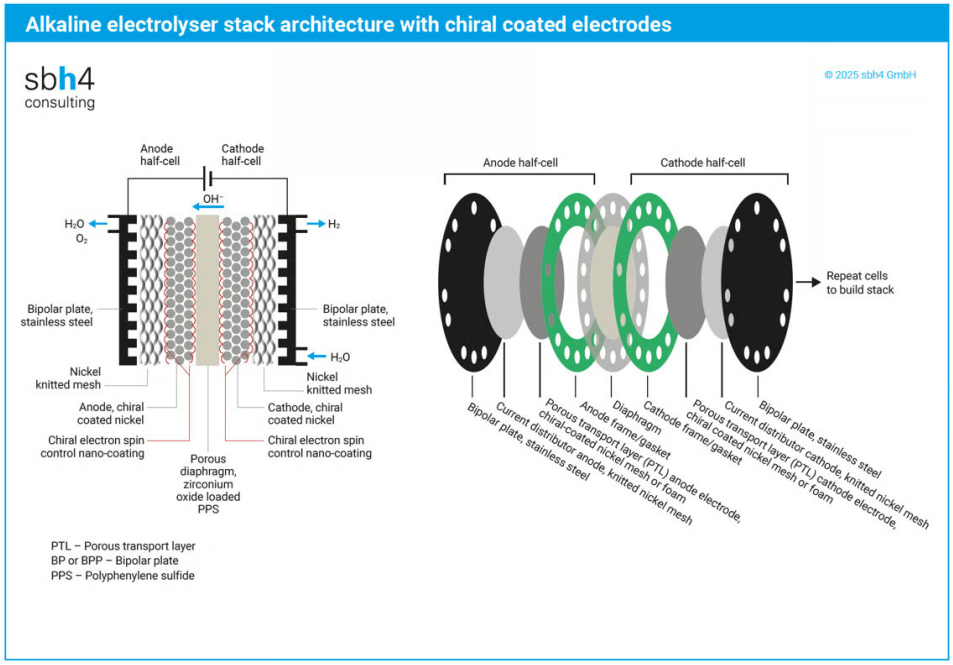
As the electrons flow through the Chiral Energy nano-coating, their spin orientation is aligned by the chiral molecules in this layer. When electrons arrive at the catalyst, they can perform their electrochemical reaction more efficiently.

"In essence, we are turbo-charging the existing range of electrolyser catalysts", explained Marom.

Versatility across electrolyser technologies

Because the spin-selective nano coating complements existing catalysts, it can be equally relevant to PEM, pressurised alkaline and low-pressure advanced alkaline systems.

"We're currently engaged in proof-of-concept studies with companies across all these electrolyser system types," said Marom. "We'd like to present our solution as a broadly applicable technology which enhances electrolysis performance across the board."



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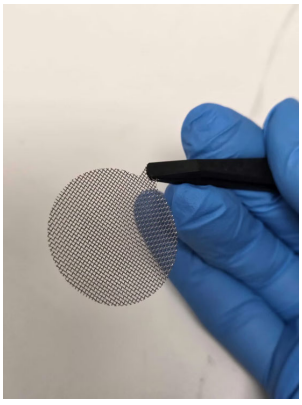
The Chiral Energy electrode coating is robust. It can operate comfortably at all state-of-the-art electrolyser temperatures, from the lower end of the range at 60°C for PEM systems to the upper end of the range at 90°C for alkaline electrolysers.

It is also unaffected by the highly alkaline electrolyte in alkaline electrolyser stacks. Furthermore, it can support current densities that are commercially relevant to all systems, including the higher current densities observed in advanced alkaline electrolysers and the most modern PEM systems.

"We can also handle pressure," Marom stressed. "PEM, AEM and many alkaline systems operate in the range of 15 to 35 bar. Our electron spin filtration nano-coating can support electrolyser operation in all these environments."

Capex and opex reductions

Putting this into the context of electrolyser production, the result could mean that for the same size of equipment, and therefore capital cost, more hydrogen can be produced from the same power input.



Chiral-coated electrolyser electrode at R&D scale © Chiral Energy

Conversely, a smaller electrolyser at lower cost can produce an equivalent amount of hydrogen as an electrolyser which does not use the chiral coatings on the electrodes.

Alternatively, the benefit of the chiral coating can be taken as an opex saving, meaning that less electrical power needs to be purchased to yield the same amount of hydrogen. Whether the benefit is taken as capex or opex, Chiral Energy is confident that its coating will reduce LCOH.

For PEM fuel cells, it says similar benefits can be achieved. For the same amount of hydrogen fuel usage, more power output can be achieved when using the spin-alignment chiral coating. Less of the energy from the hydrogen makes heat, more makes power.

"Our chirality-inducing coating works as a filter to other processes as the electrons flow through our coating into the next process stage. It's a bit like a Polaroid filter in your sunglasses," Marom said.

If it works at scale, the technology could give electrolyser manufacturers a fresh route to efficiency gains. And with power costs dominating green hydrogen production, it may be a lever few in the industry can afford to ignore.

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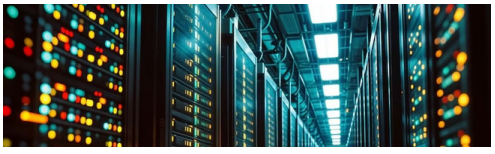

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