Quantum tunnelling in water opens the way to improved biosensing

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Credit: George Hodan/public domain

Researchers at the University of Sydney have applied quantum techniques to understanding the electrolysis of water, which is the application of an electric current to H_2O to produce the constituent elements hydrogen and oxygen.

They found that electrons can 'tunnel' through barriers in aqueous solutions away from the electrodes, neutralising ions of impurities in that water. This can be detected in changes in current, which has applications for biosensing, the detection of biological elements in solution.

This neutralisation of ions in solution is a different idea to that currently believed, where the neutralisation only happens at the electrode surface.

Quantum tunnelling in electrolysis was proposed in 1931 by Ronald Gurney (a student of Australian Nobel laureate William Bragg) but has not been confirmed until now.

The idea that tunnelling through water really does occur was suspected from recent work on the scanning tunnelling microscope, the invention of which was awarded the Nobel prize for physics in 1986.

Professor David McKenzie from the School of Physics said: "This lays the basis for new and faster methods to detect biomedical impurities in water, with potentially important implications for biosensing techniques."

Professor McKenzie also said: "A better understanding of electrolysis is becoming more important for applications in alternative energies in what is sometimes called the 'hydrogen economy'."

Without storage methods, solar energy only works when the sun is shining.

To produce energy at other times, one method is to use electricity from solar cells to electrolyse water, producing hydrogen gas which can then be stored and burned later to produce energy when needed.

The tunnelling effect refers to the quantum mechanical process where a particle moves through a barrier that in classical physical theory should not occur.

Electrons are able to 'tunnel' in biological and chemical systems in a non-trivial manner that has implications for photosynthesis and other biological systems. It occurs through barriers that are just a few nanometres thick, a billionth of a metre.

The research was conducted by Professor McKenzie and his PhD student, Enyi Guoand is published on Wednesday in the *Proceedings of the Royal Society A*.

More information: A Post Gurney Quantum Mechanical Perspective on the Electrolysis of Water: Ion Neutralization in Solution, *Proceedings of the Royal Society A*, rspa.royalsocietypublishing.or … .1098/rspa.2017.0371

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