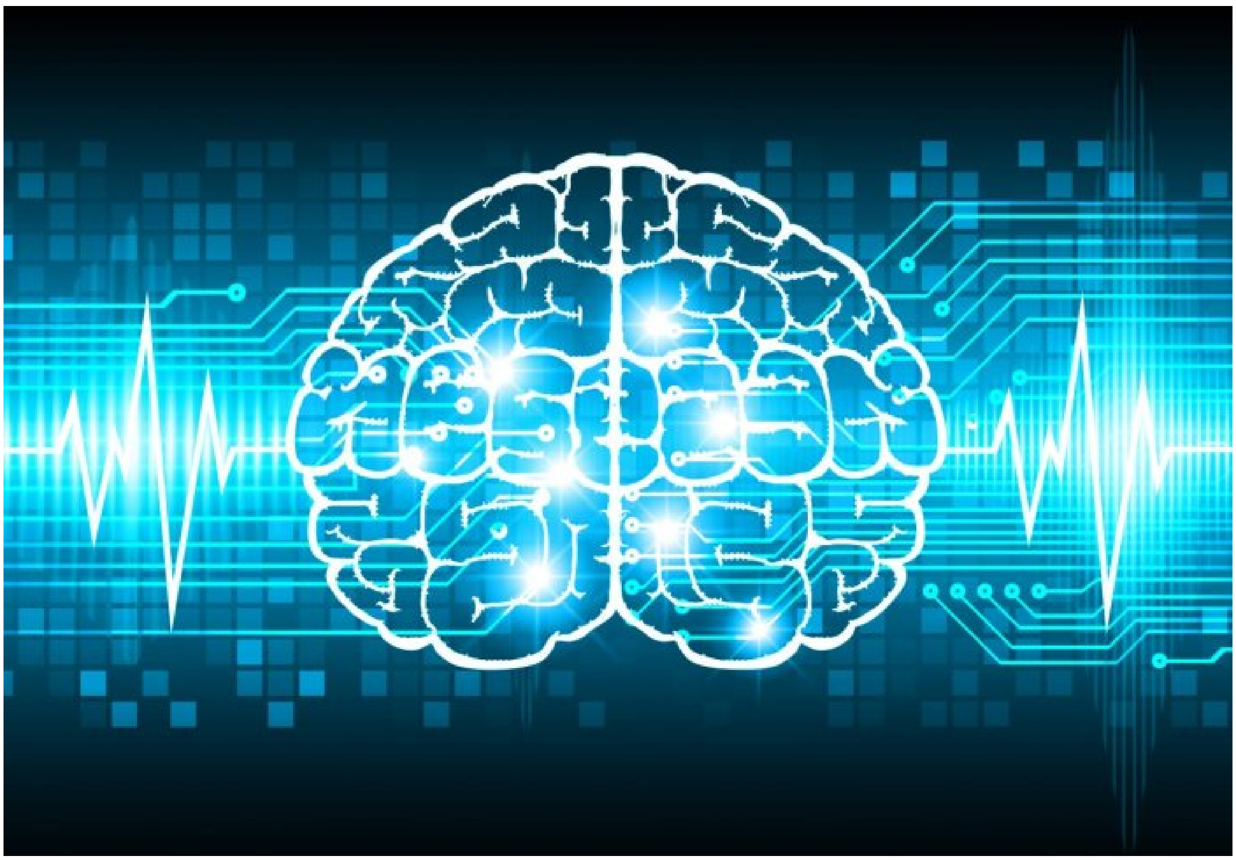
New sensor material could enable more sensitive readings of biological signals

October 7 2016, by Hayley Dunning



Credit: Imperial College London

Scientists have created a material that could make reading biological signals, from heartbeats to brainwaves, much more sensitive.

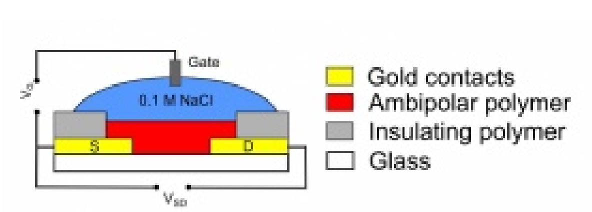
Organic electrochemical transistors (OECTs) are designed to measure signals created by electrical impulses in the body, such as heartbeats or brainwaves. However, they are currently only able to measure certain signals.

Now researchers led by a team from Imperial College London have created a material that measures signals in a different way to traditional OECTs that they believe could be used in complementary circuits, paving the way for new biological sensor technologies.

Semiconducting materials can conduct electronic signals, carried by either electrons or their positively charged counterparts, called holes. Holes in this sense are the absence of electrons - the spaces within atoms that can be filled by them.

Electrons can be passed between atoms but so can holes. Materials that use primarily hole-driven transport are called 'p-type' materials, and those that use primarily electron-driven transport are called, and 'n-type' materials.

An 'ambipolar' material is the combination of both types, allowing the transport of holes and electrons within the same material, leading to potentially more sensitive devices. However, it has not previously been possible to create ambipolar materials that work in the body.



Credit: Imperial College London

The current most sensitive OECTs use a material where only holes are transported. Electron transport in these devices however has not been possible, since n-type materials readily break down in water-based environments like the human body.

But in research published today in *Nature Communications*, the team have demonstrated the first ambipolar OECT that can conduct electrons as well as holes with high stability in water-based solutions.

The team overcame the seemingly inherent instability of n-type materials in water by designing new structures that prevent electrons from engaging in side-reactions, which would otherwise degrade the device.

These new devices can detect positively charged sodium and potassium ions, important for neuron activities in the body, particularly in the brain. In the future, the team hope to be able to create materials tuned to detect particular ions, allowing ion-specific signals to be detected.

Lead author Alexander Giovannitti, a PhD student under the supervision of Professor Iain McCulloch, from the Department of Chemistry and Centre for Plastic Electronics at Imperial said: "Proving that an n-type organic electrochemical transistor can operate in water paves the way for new sensor electronics with improved sensitivity.

"It will also allow new applications, particularly in the sensing of biologically important positive ions, which are not feasible with current devices. For example, these materials might be able to detect abnormalities in sodium and potassium ion concentrations in the brain, responsible for neuron diseases such as epilepsy."

More information: Alexander Giovannitti et al, N-type organic electrochemical transistors with stability in water, *Nature Communications* (2016). DOI: 10.1038/NCOMMS13066

Provided by Imperial College London