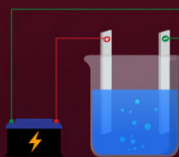


# Electrochemical synthesis now possible without electric power source

May 31 2022

## Electrochemical Synthesis Now Possible Without an Electric Power Source

Use of electric power to carry out organic synthesis or redox reactions is on the rise



However, electrosynthesis reactors that can function without a power source have wider applications

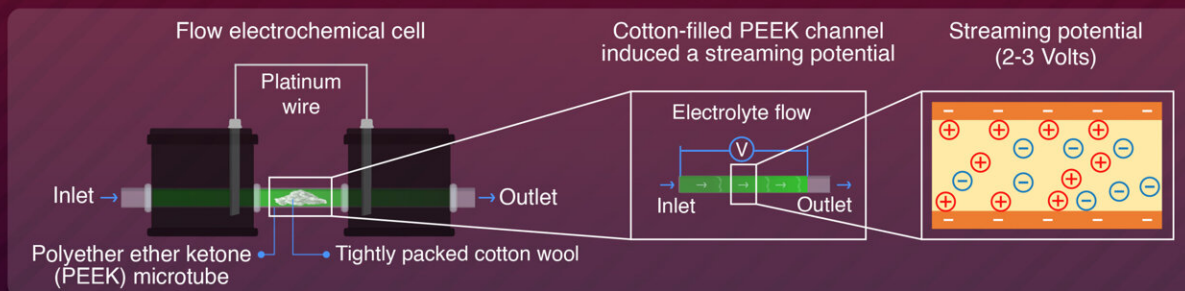


Deep sea



Aerospace

Novel power supply-independent electropolymerization technique using pressure-driven electrosynthetic reactor



Aromatic monomers tested in this system

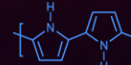
Pyrrole



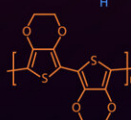
3,4-Ethylenedioxythiophene (EDOT)



Polypyrrole



PEDOT



Polymers obtained

**This new electrosynthesis process is independent of a power supply and can be used for sustainable organic synthesis, even in unpowered areas**

Credit: Tokyo Tech

Synthesis of organic compounds and polymers is at the core of many manufacturing industries. The new "electrifying synthesis" methods that can combine conventional synthetic chemistry with electrochemistry are a step closer to a sustainable tomorrow. These reactions don't require potentially harmful chemical reagents. They achieve organic synthesis by simply using electrons from an electric power source to conduct redox reactions.

Apart from being environmentally-friendly, these reactions can also be made more or less selective by fine-tuning the electric potentials. However, their dependence on a power supply limits their application in unpowered locations such as aerospace and the deep sea.

The solution to this self-contradictory problem was presented by a team of researchers led by Prof. Shinsuke Inagi from the Tokyo Institute of Technology (Tokyo Tech), Japan. In their recent study published in *Communications Chemistry*, the team provided a proof-of-concept for electrochemical polymerization of organic aromatic monomers without an external power supply. Prof. Inagi explains, "We have seen a huge leap in the development of electrochemical reactors for carrying out organic synthesis, but most of them require a power source. We wanted to build a power-independent system to make the process more accessible. And we found the answer to our quest in streaming potential-driven electrochemistry."

What exactly is this streaming potential that Prof. Inagi mentions?

When an electrolyte flows through a microchannel, a [pressure difference](#) is created due to this movement. This leads to a charge imbalance, which

gives rise to a streaming potential. The team used a custom two-chambered polyether ether ketone (or PEEK) cell connected by platinum wires and a PEEK microtube for their experiments. This PEEK microtube was tightly filled with cotton wool to create a pressure drop. When they passed an electrolyte through the microtube, it generated a streaming potential that could provide enough energy for driving the desired chemical reactions.

When the cell was operated, the electrodes in the two-chambered cell experienced both upstream and downstream streaming potential, which enabled the cell to behave like something called a split bipolar electrode (BPE). This BPE setup, accompanied by the generated streaming potential of 2-3 volts was responsible for creating conditions conducive for the [redox reactions](#) of organic monomers.

To test the polymerization abilities of this setup, the team chose two aromatic organic compounds: Pyrrole (Py) and 3,4-Ethylenedioxythiophene (EDOT). Both these monomers were successfully electropolymerized into polypyrrole (PPy) and poly-EDOT (PEDOT) respectively, without using any external power source.

This new pressure-driven, environmentally-friendly, [power supply](#)-independent reactor opens up new avenues for electrifying synthesis reactions. The insights from this study can also prove valuable when designing new electrochemical reactors for the synthesis of useful organic compounds and polymers. "The entire world is trying to make essential industrial processes greener and cleaner. Since [organic synthesis](#) is at the heart of many chemical industries, we tried to develop an electrosynthesis process that requires minimum resources and contributes towards the [sustainable development goals](#)," concludes Prof. Inagi.

**More information:** Suguru Iwai et al, Electropolymerization without

an electric power supply, *Communications Chemistry* (2022). DOI: [10.1038/s42004-022-00682-8](https://doi.org/10.1038/s42004-022-00682-8)

Provided by Tokyo Institute of Technology

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