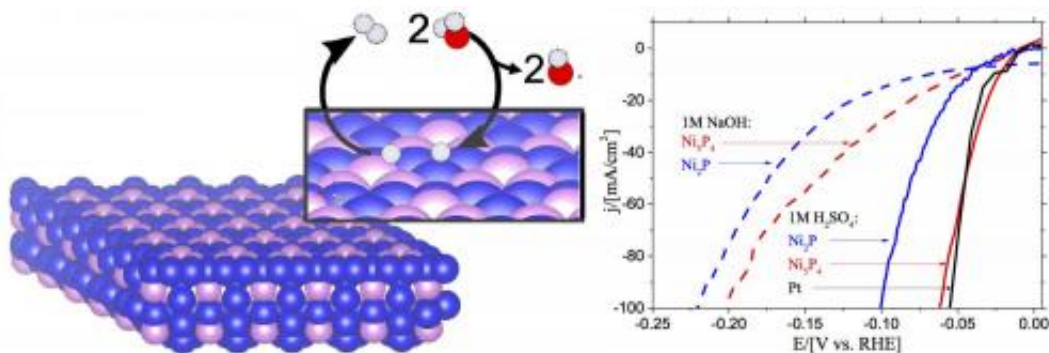


Study holds great promise for advancing sustainable energy

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Left: schematic of Ni₅P₄ surface showing water adsorption and conversion to H atoms and to H₂ product. Right: current output versus voltage input for Ni₅P₄. Credit: Rutgers University

New research published by Rutgers University chemists has documented significant progress confronting one of the main challenges inhibiting widespread utilization of sustainable power: Creating a cost-effective process to store energy so it can be used later.

"We have developed a compound, Ni₅P₄ (nickel-5 phosphide-4), that has the potential to replace platinum in two types of [electrochemical cells](#): electrolyzers that make hydrogen by splitting water through hydrogen evolution reaction (HER) powered by electrical energy, and fuel cells that make electricity from combining hydrogen and oxygen," said Rutgers Chemistry Professor Charles Dismukes. "Platinum is the

benchmark material for both devices as it has the best conversion efficiency. However, while platinum may be acceptable for making jewelry and low volume specialty applications, it is too expensive for large-scale applications such as energy storage and conversion. Our new HER catalyst, Ni₅P₄, has the strong potential to overcome this challenge."

Rutgers Chemistry Professor Martha Greenblatt, Dismukes and colleagues published their findings on the patent-pending technology in March edition of the Royal Society of Chemistry journal, *Energy & Environmental Science*.

"Scientists have been working for years to develop low-cost replacements for platinum and other noble metals used in these devices," Greenblatt said. "Ni₅P₄ is the most promising new material presently available that combines both the [energy conversion efficiency](#) of noble metals, yet is much more affordable based on the high natural abundance of its elements - over a million times greater than platinum."



Rutgers University chemistry professors Martha Greenblatt and Charles Dismukes in a laboratory on the Busch Campus in Piscataway. Credit: Photo by Nick Romanenko/Rutgers University

The researchers believe that Ni₅P₄ should lower the material costs of both electrolyzers and fuel cells, while maintaining the efficiencies of these technologies for electrical conversion. "These devices are two key technological advances that could open the door to renewable fuels produced from sustainable feedstocks - water and sunlight," Dismukes said.

The next step for the research is to test the operating stability and efficiency of the compound over extended time periods in commercial electrolyzers and fuel cells. As these devices have different requirements for operation, independent tests for both will be needed. Rutgers has partnered with Proton OnSite of Wallingford, Conn., a commercial manufacturer of electrolyzers, to test Ni₅P₄ as an appropriate HER catalyst.

To achieve the overall water splitting process, the HER catalyst cathode will be combined with an oxygen-evolving (OER) catalyst anode. The Rutgers team has previously developed a noble-metal-free OER catalyst - LiCoO₂ (lithium cobalt oxide) - that has shown promising performance in preliminary tests at Proton OnSite.

"If used together, these catalysts could eliminate the need for expensive noble metal based electrode materials," Greenblatt said.

Funding for the Ni₅P₄ research was provided by the Air Force Office of

Scientific Research, NATCO Pharma Ltd. and Rutgers, while the OER research is now being funding by the Department of Energy Office of Energy Efficiency and Renewable Energy.

In related work, scientists from Rutgers and Proton OnSite are partnering with members of the Solar Fuels Institute (SOFI) of Telluride, Colo. on a demonstration project that seeks to build a solar-powered mobile electrolyzer for making public demonstrations showing the production of a renewable liquid fuel using only sunlight, water and carbon dioxide as inputs.

Joining Professors Dismukes and Greenblatt as co-authors of the Energy & Environmental Science article were Postdoctoral researchers Drs. Anders Laursen, Mariana Whitaker, Maria Retuerto, and Tapati Sarkar, and undergraduate Kelly Patraju, all of Rutgers; Dr. Nan Yao of Princeton University; and Professor Kandalam Ramanujachary of Rowan University.

Provided by Rutgers University

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