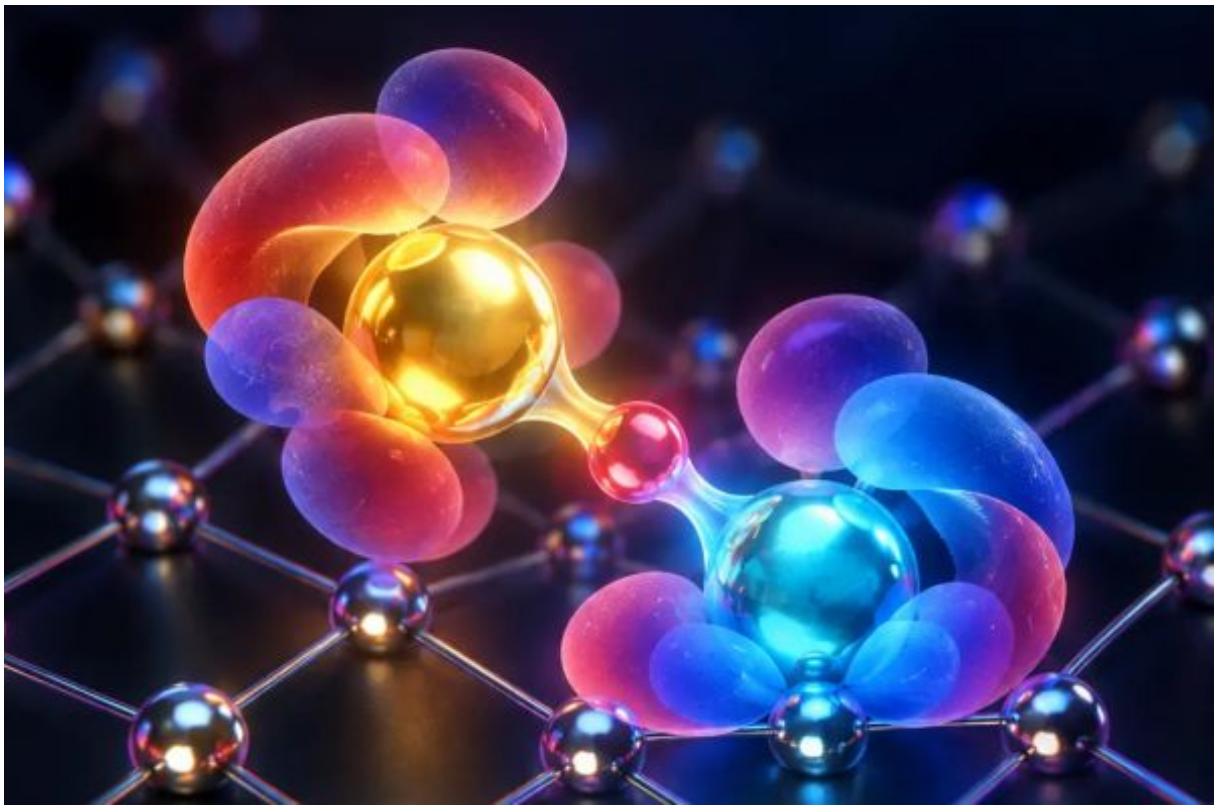


A perfect couple: chromium keeps ruthenium grounded in water electrolysis

ICFO researchers and collaborators have found that chromium protects ruthenium from excessive oxidation, forming the perfect couple for stabilizing catalysts during water electrolysis. These results, published in Nature Materials, pave the way toward more durable catalysts for green hydrogen production.

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They say opposites attract, and many couples do fit this pattern. One is pragmatic and down-to-earth, while the other is a dreamer with their head in the clouds. Yet, these differences make them perfect for each other.

According to researchers at ICFO, chemical interactions between atoms are not that different. Ruthenium, for instance, belongs to the i¿½dreameri¿½ class. It is commonly sed in single-atom catalysts that speed up water electrolysis, which splits water to obtain g een hydrogen. However, on its own, ruthenium tends to over-oxidize and dissolve du

ing operation, like an idealist who takes flight without looking b
ck. In an article published in Nature Materials, ICFO researchers, **Tengyu Chen**, **Dr. Kaiwen Wang**, **Dr. Lu Xia**, **Dr. Wulyu Jiang**, **Dr. Linlin Yang**, **Dr. Kaiqi Zhao**, **Ranit Ram**, **Dr. Junmei Chen**, **Dr. Marinos Dimitropoulos**, **Dr. Viktoria Golovanova**, **Prathama Haldar**, **Dr. Barbara Polesso**, **Dr. Aparna M. Das**, **Dr. Sunil Kadam**, led by **Prof. at ICFO F. Pelayo Garcia de Arquer**, and in close collaboration with the University of Bayreuth, Fujian Institute of Research on the Structure of Matter, the Institut de Recerca en Energia de Catalunya (IREC), the Catalan Institute of Nanoscience and Nanotechnology (ICN2), Chongqing University, and the National Institute for Space Research (INPE), now present the **perfect partner to keep ruthenium grounded: chromium**.

i¿½Many people know that chromium helps stainless steel resist corrosion,i¿½ says Te
gyu Chen, first co-author of the article. i¿½So we wondered whether it could also be a great partner for restless ruthenium, and began to explore its protective role at the
tomic sca
e.i¿½ To do so, the researchers designed a synthesis method that brought ruthe
ium and chromium atoms into close proximity within an oxide scaffold, and then took a step back to watch how the two go
along. Using advanced electron microscopy and synchrotron spectroscopy, they obser
ed that neighbouring ruthenium and chromium atoms interacted through oxygen bridges, and that **chromium buffered ruthenium's excessive oxidation** while preserving its catalytic activity. In effect, the atoms stopped behaving individually and instead formed local units that responded cooperatively during catalysis.

i¿½It was like seeing Cupid's arrow in front of us, striking two different atomic elements,i
?½ says Kaiwen Wang, first co-author of the article. i¿½And these coupled atomic units w
rk in tandem to control how the catalyst evolves during operation, **improving its durability**. It was meant to be!,i¿½ adds Lu Xia, also first co-author of the articl
. The next question is how to make these atoms not only fall in love, but also stay together f
r good. Observing how these couples form at higher resolution and gaining finer control ov
r this process will help the researchers generalize the underlying principle and translate it in
o practical technology, a goal the team now plans to pursu
. i¿½More efficient and durable catalysts could make renewable hydrogen production
ess dependent on scarce precious metals and more affordable,i¿½ explains Prof. Pelayo
arcia de Arquer, lead researcher of the study. i¿½Strategies like this one, which keep highl
active catalysts stable, **support the long-term goal of producing clean hydrogen** for use as a fuel.i¿

Reference:

T. Chen, K. Wang, L. Xia, et. al., Proximal redox coupling enables oxidation damping for stable water electrolysis, Nat. Mat. (2026).?
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