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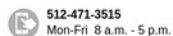
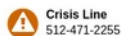
UT Austin, McKetta Department of Chemical Engineering

Why Deaths of Despair Are Increasing in the US and Not Other Industrial Nations—Insights From Neuroscience and Anthropology

Peter Sterling, PhD¹; Michael L. Platt, PhD^{1,2,3}

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Why it is important to know the literature

- To contribute knowledge, you need to know the state-of-the-art (in the latest results, methods, ways of thinking, technologies, challenges)
- Things are always more complex and subtle than you think
- Become aware of the established and emerging experts in the field
- Become an expert yourself and learn the jargon
- Get a renewed perspective on your own research

Literature review is a continuous process with many feedback loops

Anatomy of a journal article

ARTICLES

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An efficient nickel hydrogen oxidation catalyst for hydroxide exchange membrane fuel cells

Welyan Ni¹*, Teng Wang¹*, Florent H. A. J. van den Hul¹, Xinyu Chen¹, Seunghwa Lee¹, Liang Yao¹, Andreas Schüller¹, Jeremy S. Luterbacher¹ and Xile Hu^{1,2}✉

The hydroxide exchange membrane fuel cell (HEMFC) is a promising energy conversion technology but is limited by the need for platinum group metal (PGM) electrocatalysts, especially for the hydrogen oxidation reaction (HOR). Here we report a Ni-based HOR catalyst that exhibits an electrochemical surface area-normalized exchange current density of 70 $\mu\text{A cm}^{-2}$, the highest among PGM-free catalysts. The catalyst comprises Ni nanoparticles embedded in a nitrogen-doped carbon support. According to X-ray and ultraviolet photoelectron spectroscopy measurements, the electronic interaction between the Ni nanoparticles and the support leads to balanced adsorption/desorption energies, which are the likely origin of the catalyst's high activity. PGM-free HEMFCs employing this catalyst give a peak power density of 488 mW cm^{-2} , up to 6.4 times higher than previous best-performing analogous HEMFCs. This work demonstrates the feasibility of efficient PGM-free HEMFCs.

The proton exchange membrane fuel cell (PEMFC) is an emerging clean energy technology. However, it requires heavy usage of Pt catalysts, perfluorinated membranes and acid-tolerant stack hardware, leading to high cost. The hydroxide exchange membrane fuel cell (HEMFC) is potentially a cost-effective alternative to the PEMFC because less costly catalysts, membranes and stack hardware might be used in alkaline medium. One important target for the development of HEMFCs is to stimulate the need for platinum group metals (PGMs). To date, PGM-free catalysts for the oxygen reduction reaction (ORR) at the cathode have achieved performances comparable to their PGM counterparts^{1–3}, and highly conductive and stable hydroxide exchange membranes have emerged. However, there is a lack of active PGM-free catalysts for the hydrogen oxidation reaction (HOR) at the anode, representing a major barrier to the progress of HEMFCs. For example, HEMFCs with Pt/C as HOR catalysts exhibit a low exchange current density (i_0) of 0.1 mA cm^{-2} at 130 °C, whereas Pt/C as ORR catalysts can reach a peak power of 2.350 W cm^{-2} (ref. 4). In contrast, HEMFCs with Pt/C as ORR and ORR catalysts have a highest peak power density of merely 0.6 mW cm^{-2} (ref. 5). As a result, the US Department of Energy (DOE) has set a peak power density target of 600 mW cm^{-2} for PGM-free HEMFCs in 2030 (ref. 6).

HEMFCs pose challenges for HOR catalysts, not only in having a high intrinsic activity, but also in exhibiting other desirable properties, such as a large surface area, porous structure and resistance to high temperature, anodic potential and CO poisoning. Among Earth-abundant metals, nickel proves to be the best candidate to meet these requirements. Nevertheless, state-of-the-art Ni catalysts typically exhibit intrinsic activity below 40 $\mu\text{A cm}^{-2}$ per electrochemical surface area (ECSA) of the catalyst (400 $\mu\text{A cm}^{-2}$, ref. 7). Although a few catalysts have a higher intrinsic activity, their surface areas are very small^{8–10}. Furthermore, some catalysts exhibit good mass activity in model studies involving rotating disc electrode (RDE) measurements, but they are prone to oxidation and are unsuitable for practical devices^{11–13}. In fact, the stability of nickel in a fuel cell working environment, that is, at elevated temperature and high current density, is not well demonstrated. As a result, previously reported Ni catalysts do not exhibit good performance in a complete cell configuration, especially with a PGM-free cathode. Here, we report a Ni catalyst that exhibits an intrinsic activity of 70 $\mu\text{A per cm}^2$ Ni (70 $\mu\text{A cm}^{-2}$), PGM-free HEMFCs employing this catalyst gave a peak power density of 488 mW cm^{-2} at 95 °C and 443 mW cm^{-2} at 80 °C, about six times higher than the previous best analogous HEMFCs. The superior activity of our catalyst is due to balanced hydrogen binding energy (HBE) and hydroxide binding energy (OHBE), resulting from a fine-tuned Ni-support interaction.

The catalyst Ni-H₂-NH₂ was prepared by pyrolysing a Ni-based metal-organic framework, Ni₂(BTC)₂(BTB)₂ (nickel 1,4,5,8-tetracarboxylate), at 390 °C in a mixed atmosphere of H₂/N₂/N₂ (4.3:3.3:6.6:1, v/v/v), see Materials and methods and Supplementary Figs. 1–3). NH₂ was used to introduce nitrogen doping to regulate the electronic structure of Ni (ref. 7), while H₂ was used as a reducing agent to form metallic Ni. The temperature and partial pressure of each gas were carefully optimized. Reference compounds Ni-H₂ and Ni-NH₂ were also prepared using the same method with H₂/N₂ and NH₂/N₂ ratios of 4.6:95.4 and 33.6:66.4 (v/v), respectively (Fig. 1a).

Transmission electron microscopy (TEM) showed that Ni-H₂-NH₂ and Ni-NH₂ contained small, separated nanoparticles with an average size of 13.3 ± 3.5 and 8.6 ± 2.1 nm, respectively, whereas Ni-H₂ was composed of striped particles with a large grain size (Fig. 1b–d and Supplementary Fig. 4). The Supplementary Notes and Supplementary Figs. 5–10 provide detailed characterization data for Ni-H₂-NH₂, Ni-NH₂ and Ni-H₂. High-resolution

Author affiliation

Laboratory of Inorganic Synthesis and Catalysis, Institute of Chemical Sciences and Engineering, École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland. ²Department of Chemical and Applied Engineering, University of California, Berkeley, CA, USA. ³Laboratory of Sustainable and Catalytic Processing, Institute of Chemical Sciences and Engineering, École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland. ⁴Solar Energy and Building Physics Laboratory, Institute of Chemical Sciences and Engineering, École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland. ⁵These authors contributed equally: Welyan Ni, Teng Wang, Florent H. A. J. van den Hul, Xinyu Chen, Seunghwa Lee, Liang Yao, Andreas Schüller, Jeremy S. Luterbacher and Xile Hu.

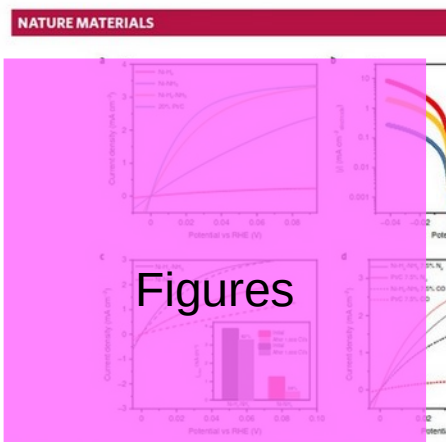


Fig. 2 | Electrochemical HOR. **a**, HOR polarization curves for Ni-H₂-NH₂, Ni-NH₂ and Ni-H₂ and commercial Pt/C (200 $\mu\text{g cm}^{-2}$). **b**, Butler-Volmer plots of the HOR current densities shown in **a**. **c**, Accelerated durability test (ADT) results. The solid line is the initial LSV and the dashed line is the LSV after the durability test. **d**, CO poisoning experiments for Ni-H₂-NH₂ and 20 cycles of CV after 1000 CV scans. **e**, CO poisoning experiments for Ni-H₂-NH₂ and 20 cycles of CV after 1000 CV scans before recording the HOR polarization curve.

Table 1 | Comparison of state-of-the-art Pt-free HOR catalysts

Catalyst	Mass activity at $i_0 = 50 \text{ mV}$ (mA mg _{Ni} ⁻¹)	i_0 (mA cm _{Ni} ⁻²)	Reference
Ni-H ₂ -NH ₂	59.2	70	This work
Ni-NH ₂	12.7	20	
Ni-H ₂	0.8	18	
Ni/C	0.1	18	
Pt-Pd/Ni	10.0	20	
Pt-Ni/C	10.0	20	
GO/Pt-Ni/C	12.3	30	
Ni/NiO/C-700	6.0	26	
Ni/NiO/CNT	9.3	28	
Ni/NiO/NF	3	3	
PS/C-GdO ₂	54.5	54.5	

physiisorption). Our fitting results showed that the hydrogen binding strength follows the order Ni-H₂ > Ni-H₂-NH₂ > Ni-NH₂ > Ni-H₂ > Pt/C (Fig. 3b). These data agree with the prediction of d-band theory. We then probed whether OHBE was relevant for the HOR on our catalysts through isotopic experiments. We tested the HOR on Ni-H₂-NH₂ in deuterated electrolytes (Fig. 3c and Isotopic study in the Supplementary Notes). After removing the diffusion

NATURE MATERIALS

demonstrating the ability of our catalyst to w temperature and large current. Pt migration in the fuel cell test was excluded by XPS an face after the durability test (Supplemental Fig. S10). The catalyst was prepared by a sol-gel process (Supplementary Fig. S2). Overall, the robustness of our new Ni catalyst under de demonstrate the potential of Earth-abundant development of efficient PGM-free HEMFC

Online content

Any methods, additional references, N ing summaries, source data, extended data, acknowledgements, peer review author contributions and competing inter data and code availability are available at [s41563-022-01221-5](https://doi.org/10.1038/s41563-022-01221-5).

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ARTICLES

Methods

Materials. Nickel source hexachloride (NiCl₂·6H₂O, 99.999%, Alfa Aesar), hydrogen peroxide (H₂O₂, 30%, 99.999%, Alfa Aesar), sodium hydroxide (NaOH, 99.999%, Alfa Aesar), nickel sulfate hexahydrate (NiSO₄·6H₂O, 99.999%, Alfa Aesar), nickel chloride hexahydrate (NiCl₂·6H₂O, 99.999%, Alfa Aesar), nickel acetate tetrahydrate (Ni(CH₃COO)₂·4H₂O, 99.999%, Alfa Aesar), nickel nitrate hexahydrate (Ni(NO₃)₂·6H₂O, 99.999%, Alfa Aesar), nickel carbonate (NiCO₃, 99.999%, Alfa Aesar), nickel hydroxide (Ni(OH)₂, 99.999%, Alfa Aesar), nickel chloride (NiCl₂, 99.999%, Alfa Aesar), nickel sulfate (NiSO₄, 99.999%, Alfa Aesar), nickel acetate (Ni(CH₃COO)₂, 99.999%, Alfa Aesar), nickel nitrate (Ni(NO₃)₂, 99.999%, Alfa Aesar), nickel carbonate (NiCO₃, 99.999%, Alfa Aesar), nickel hydroxide (Ni(OH)₂, 99.999%, Alfa Aesar), nickel chloride (NiCl₂, 99.999%, Alfa Aesar), nickel sulfate (NiSO₄, 99.999%, Alfa Aesar), nickel acetate (Ni(CH₃COO)₂, 99.999%, Alfa Aesar), nickel nitrate (Ni(NO₃)₂, 99.999%, Alfa Aesar), nickel 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chloride (NiCl₂, 99.999%, Alfa Aesar), nickel sulfate (NiSO₄, 99.999%, Alfa Aesar), nickel acetate (Ni(CH₃COO)₂, 99.999%, Alfa Aesar), nickel nitrate (Ni(NO₃)₂, 99.999%, Alfa Aesar), nickel carbonate (NiCO₃, 99.999%,

Anatomy of a journal article

Lots of (some click-bait-y) online advice,
pick and choose what works for you

- How to (seriously) read a scientific article *Science*
- Ten simple rules for reading a scientific paper *PLOS*
- Strategic Reading, Ontologies, and the Future of Scientific Publishing *Science* (interesting historical perspective)
- Robert Siegel, PhD. “ReadingScientific Papers,” Stanford University

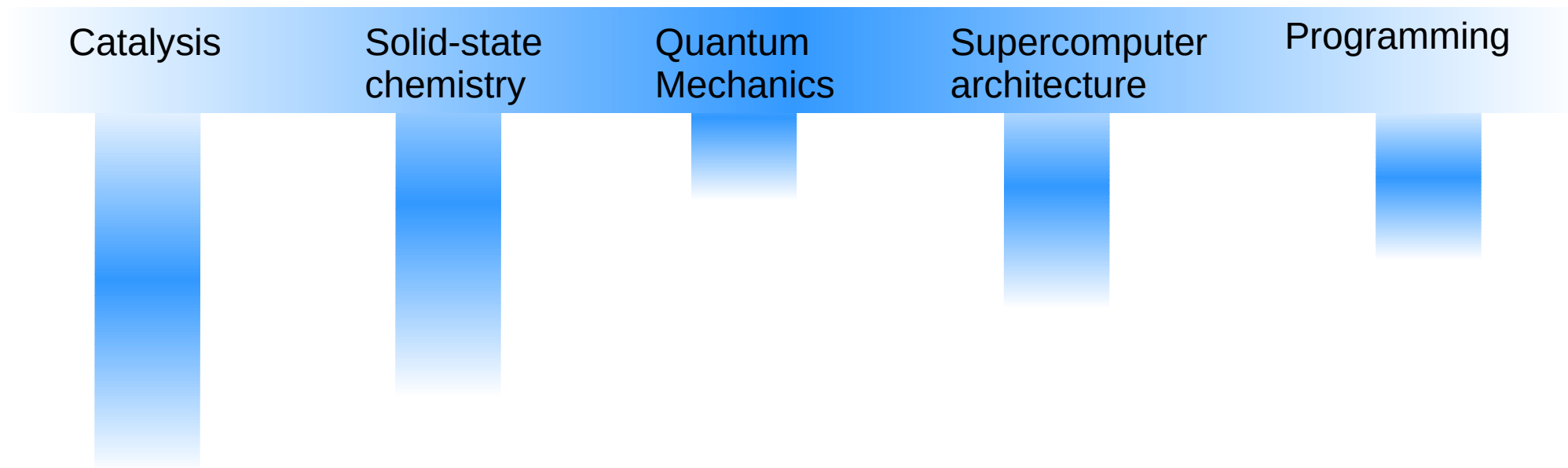
Anatomy of a journal article

Many different types of journal articles:

- Article
- Communication/Letter
- Review
- Perspective
- Tutorial/Methods
- Software (e.g., JOSS)

...

Reading broadly and deeply



Make note of what you do and do not know.

Time spent on focused learning of new topics will always eventually pay off

Prioritize what will enable you to progress in your research.

Questions to ask yourself while reading

Introduction

- Are the motivations clear and compelling?
- Are the objectives clear and compelling?
- Is the literature presented up-to-date?
- Are the appropriate references cited?

Methods

- Are the methods appropriate?
- Have the authors properly calibrated/
converged the authors' results?

Results

- Are the conclusions supported by data?
- Are the conclusions logical and well-reasoned?
- Is there sufficient data?
- Is the data clearly presented?

Discussion

- What claims are supported by the data?
- What claims are supported by the literature?
- Are the results consistent with literature?
- Are the authors comparing apples-to-apples?
- Do the assumptions match the system?
- **Are you convinced of the conclusions?**

Questions to ask yourself while reading

TABLE I. Fundamental and optical band gap of BiVO_4 as obtained with various methods. The fundamental gap E_g does not account for the effects of spin-orbit coupling, electron-hole interaction or atomic vibrations. The fundamental gap $E_g^{\text{corr.}}$ includes corrections from spin-orbit coupling, nuclear quantum effects, and thermal vibrations. $E_g^{\text{opt.}}$ corresponds to the optical band gap. \tilde{W}_0 and \tilde{W} correspond to the inclusion of the vertex corrections in the screening.

	E_g (eV)	$E_g^{\text{corr.}}$ (eV)	$E_g^{\text{opt.}}$ (eV)
PBE	2.18	1.48	1.37
HSE	3.18	2.13	2.02
PBE0	3.92	2.87	2.76
G_0W_0 @PBE	3.52	2.47	2.36
G_0W_0 @HSE	3.68	2.63	2.52
G_0W_0 @PBE0	3.98	2.93	2.82
$G_0\tilde{W}_0$ @PBE	3.39	2.34	2.23
$G_0\tilde{W}_0$ @HSE	3.43	2.38	2.27
$G_0\tilde{W}_0$ @PBE0	3.63	2.58	2.47
$\text{QSG}\tilde{W}$	3.64	2.59	2.48
Expt.	2.4–2.5 [7–11]		

- Example: electronic band gap
- fundamental v optical band gap
 - Renormalization of band gap

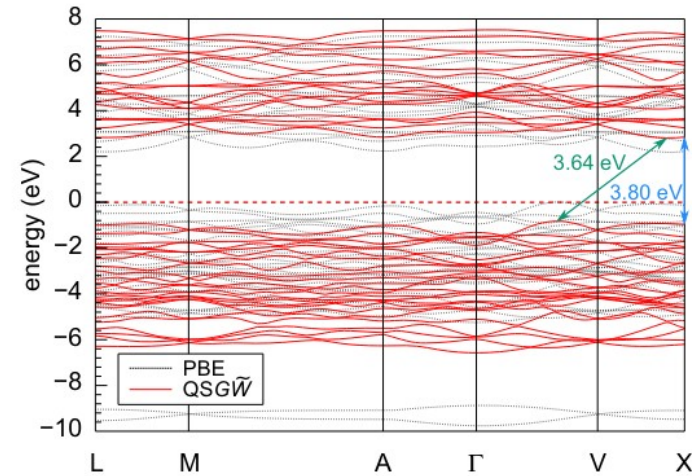
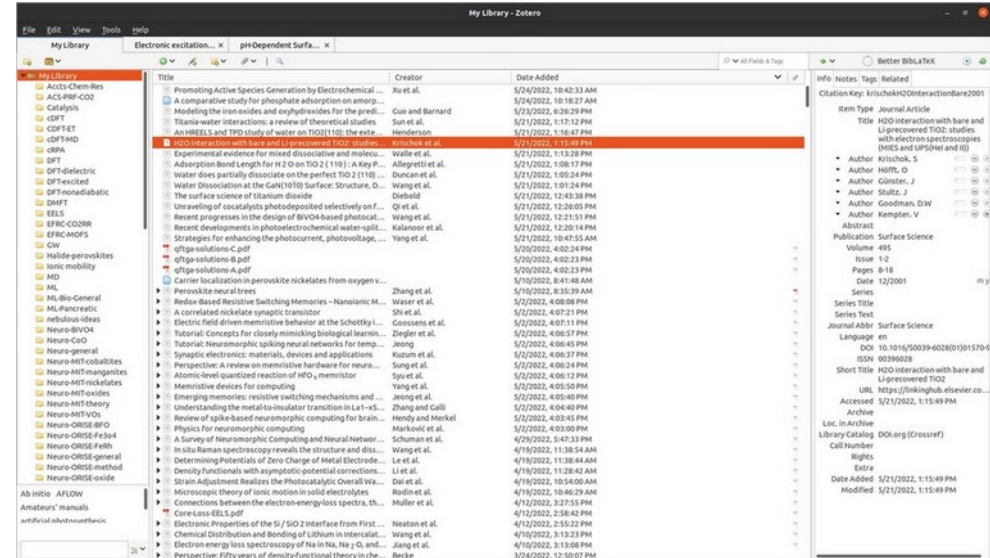


FIG. 2. Band structure of m-BiVO₄ calculated using the PBE functional (black dashed line) and the QSGW method (red solid lines). The QSGW band structure is generated assuming, for each group of bands, a linear relationship between the GW corrections and the energy. The energies are referred to the PBE valence-band maximum. The point X corresponds to (0.5, 0, 0.25) in reduced units, for the positions of the other points see Ref. [16].

Use a reference manager

Example: (open-source)



Have a note taking system

Example: Joplin, WYSIWYG markdown

The screenshot displays the Joplin application window. The title bar reads "Joplin". The menu bar includes "File", "Edit", "View", "Go", "Notebook", "Note", "Tools", and "Help". The left sidebar shows a "NOTEBOOKS" panel with "All notes" and "Session B41: Oxide thing films, surface". Below this is a "TAGS" panel. The main content area shows a markdown document titled "Session B41: Oxide thing films, surfaces, and interfaces". The document content includes:

- STO ultimate tensile strength (comparable to CNT and ZnO in terms of strain)
- =====
- # P25: predicting rare even kinetics in complex systems with theory, simulations, ML**
- ## Peter Bolhuis (U Amsterdam)**
- Incorporating rate constants as kinetic constraints in molecular dynamics simulations
- maxent principle
- !f66ba2374264a18bb13c1d41238e004f4.png!f66ba2374264a18bb13c1d41238e004f4.png
- kinetic ensembles- interconversion rates;
- method for combining MD with experimental information with max path entropy
- obvious strategy - modify FF, recompute kinetics, compare to exps; \$\$
- bett option: reuse existing trajectory data and correct for error
- imagine lots of trajectories between states A and B; including paths for AA and BB
- nonequilibrium stat mech; path entropy looks like Hilbert
- optimize entropy (normalized), ensemble average of certain observable --> path probability; similar to MaxEnt but depends on path x; tilting of path ensemble (Science 2009 publication)
- introduce set of interfaces; JCP 147 152722 (2019); crossing probability for path- product of lots of these probabilities --> kinetic rate
- examples: methane hydrate nucleation, DNA basepair rotation (lots really large systems)
- !6cad7583069352d3ad847b29c8fc9c85.png!c777fdd815ed4d78bb37d07152b68e6)
- add a langragian formalism- constrain rate constant; analogous to MaxEnt- but get unphysical discontinuities; impose the correct rate at all interfaces
- doing stuff with D.E. Shaw; PNAS 118, e2012423118 (2021); using input data from Anton MD trajectory of chignolin
- !b5b00645e26ab852a126943579628847.png!c30e25620fe841d799e2b90f45789301)

On the right side of the application, there is a preview pane showing the rendered version of the document. It includes the same text as the left pane, but with a blue header "MaxEnt principle" and a diagram illustrating the principle. The diagram shows a plot of the probability distribution $P(x)$ versus the reaction coordinate x , with a blue curve representing the distribution and a red curve representing the experimental data. The diagram also shows the Lagrange function \mathcal{L} and the general solution $P_{ME}(x) \propto e^{-\sum_{i=1}^M \beta_i (\int dx s_i(x) P(x) - s_i^{exp}) - \lambda (\int dx P(x) - 1)}$.

Have a note taking system

Example: Lyx, WYSIWYG TeX

~/wwwennie@gmail.com/UT-Austin/Research/2022-Na-EELS/xas-eels-theory/xps-practice-theory.lyx - lyX

File Edit View Insert Navigate Document Tools Help

Standard

Efficient simulation of near-edge x-rayabsorption fine structure (NEXAFS) in density-functional theory: Comparison of core-level constraining approaches;
<https://dx.doi.org/10.1063/1.5083618>

	explicit			implicit			neutral implicit		
	OS	ΔSCF	TS	OS	TS	TS	OS	TS	TS
ΔE	ΔE	ΔE	ΔE	ΔE	ΔE	ΔE	ΔE	ΔE	ΔE
q _c	1	0	1/2	0	1/2	1/2	0	1/2	1/2
q _v	0	1	1/2	1/2	0	0	1	1/2	1/2

FIG. 1. Schematic illustration of the occupational constraints used in various core-hole constraining approaches. The table shows the corresponding fractional occupations of the core, q_c , and virtual, q_v , Kohn-Shan eigenstates, whether the evaluation is based on total energy differences (ΔE) or KS eigenvalue differences (Δε) and whether the scheme explicitly considers the final-state excited electron (e) or not. Explicit consideration requires that one separate calculation needs to be performed for each excited state configuration on each atom (herein q_c for a single q_c), whereas the implicit neutral approaches typically require only the lowest energy core-excited state (a single q_c constraint per atom).

- rely on time-dependent perturbation theory using Fermi's golden rule
- approximate excited state via constraining occupations
- ΔSCF: $\Delta E_{\Delta SCF} = E(q_c = 0, q_v = 1) - E(q_c = 1, q_v = 0)$ where subscripts q_c and q_v indicate occupations of core and virtual levels
- methods based on ΔSCF branching off its integral variant and Slater-Janak theorem, $\frac{\partial E}{\partial q_i} = \epsilon_i$

$$\Delta E_{\Delta SCF} = \int_{x=1}^0 \frac{dE(q_c=x, q_v=1-x)}{dx} dx$$

$$\square = \int_{x=1}^0 \left(\frac{dE(q_c=x, q_v=1-x)}{dq_c} \frac{dq_c}{dx} + \frac{dE(q_c=x, q_v=1-x)}{dq_v} \frac{dq_v}{dx} \right) dx$$

$$\square = \int_{x=1}^0 \left(\frac{dE(q_c=x, q_v=1-x)}{dq_c} - \frac{dE(q_c=x, q_v=1-x)}{dq_v} \right) dx$$

splitting the integral and using the fact that $\frac{\partial q_c}{\partial x} = 1$ and $\frac{\partial q_v}{\partial x} = -1$

$$\Delta E_{\Delta SCF} = \int_{x=1}^0 (\epsilon_c(q_c=x, q_v=1-x) - \epsilon_v(q_c=x, q_v=1-x)) dx$$

- Slater's Transition state (TS) approach (approximate above integral with midpoint rule) $\int_a^b f(x) dx \approx (b-a)f(a+b)/2$: $\Delta E_{TS} = \epsilon_v(q_c = 0.5, q_v = 0.5) - \epsilon_c(q_c = 0.5, q_v = 0.5)$

Font: Default

Set up alerts in your feed



<https://www.youtube.com/watch?v=6UsQ1yTR03Q>

Email alerts/RSS Feed by publisher
(may need account registration):

American Chemical Society Journals

American Institute of Physics

Nature

Science Magazine

Elsevier ScienceDirect Alerts

IEEE Xplore

Oxford University Press

Springer

Wiley Interscience



RSS Feed

How to Generate Search Terms

Create a Research Topic

Enter your research topic below. Try to limit the topic to one sentence that fully describes your research. Here are a few examples:

Effects of media on women's body image

Trends in information technology in the workplace

Fast food causes health risks for children

Your topic: electronic structure and optical properties of semiconductors

next

Help with generating keyword search from UT Libraries

Look to Reviews and Perspectives

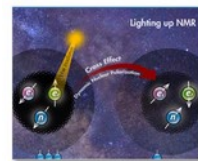
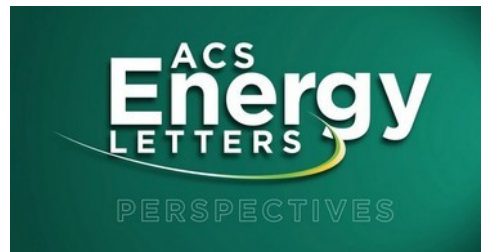
**ANNUAL
REVIEWS**

**CHEMICAL
REVIEWS**



ACCOUNTS
of chemical research

Perspectives- often by journal article, e.g.,



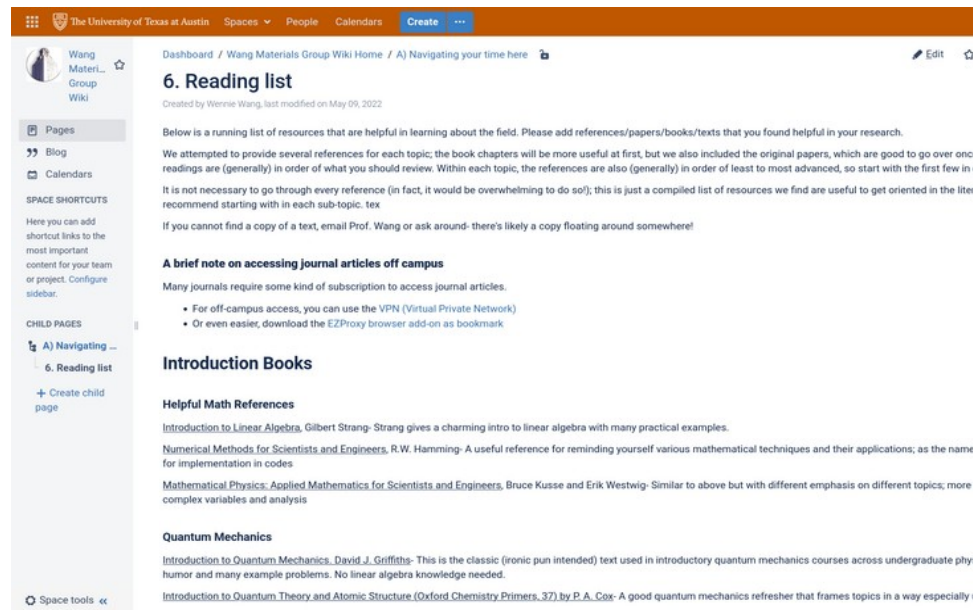
Perspectives

Perspectives are brief, peer reviewed reports highlighting topics of general interest in physical chemistry and related disciplines.

[View Perspectives from *The Journal of Physical Chemistry Letters*](#)

Don't forget the textbook (and library)

Wiki Reading List



The screenshot shows a Wiki page titled "6. Reading list" on the University of Texas at Austin's Wiki platform. The page is part of the "Wang Materials Group Wiki Home" and is created by Wernie Wang, last modified on May 09, 2022. The page content includes a brief introduction to the reading list, a note on accessing journal articles off campus, and sections for "Introduction Books", "Helpful Math References", and "Quantum Mechanics". The left sidebar shows navigation options like "Pages", "Blog", "Calendars", and "SPACE SHORTCUTS".

Dashboard / Wang Materials Group Wiki Home / A) Navigating your time here

6. Reading list

Created by Wernie Wang, last modified on May 09, 2022

Below is a running list of resources that are helpful in learning about the field. Please add references/papers/books/texts that you found helpful in your research.

We attempted to provide several references for each topic; the book chapters will be more useful at first, but we also included the original papers, which are good to go over once readings are (generally) in order of what you should review. Within each topic, the references are also (generally) in order of least to most advanced, so start with the first few in. It is not necessary to go through every reference (in fact, it would be overwhelming to do so!); this is just a compiled list of resources we find are useful to get oriented in the literature.

If you cannot find a copy of a text, email Prof. Wang or ask around- there's likely a copy floating around somewhere!

A brief note on accessing journal articles off campus

Many journals require some kind of subscription to access journal articles.

- For off-campus access, you can use the VPN (Virtual Private Network)
- Or even easier, download the EZProxy browser add-on as bookmark

Introduction Books

Helpful Math References

Introduction to Linear Algebra, Gilbert Strang- Strang gives a charming intro to linear algebra with many practical examples.

Numerical Methods for Scientists and Engineers, R.W. Hamming- A useful reference for reminding yourself various mathematical techniques and their applications; as the name for implementation in codes

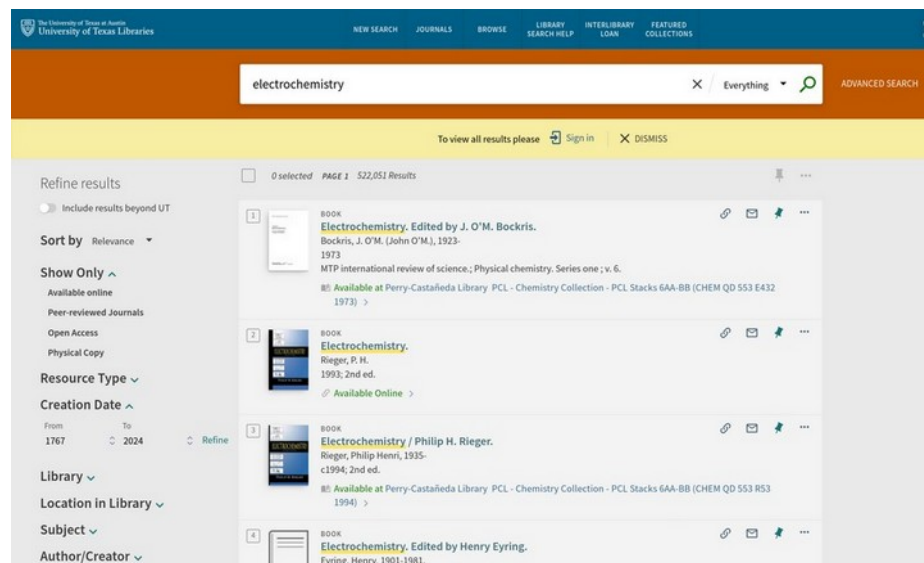
Mathematical Physics: Applied Mathematics for Scientists and Engineers, Bruce Kusse and Erik Westwig- Similar to above but with different emphasis on different topics; more complex variables and analysis

Quantum Mechanics

Introduction to Quantum Mechanics, David J. Griffiths- This is the classic (ironic pun intended) text used in introductory quantum mechanics courses across undergraduate physics and many example problems. No linear algebra knowledge needed.

Introduction to Quantum Theory and Atomic Structure, (Oxford Chemistry Primers, 37) by P.A. Cox- A good quantum mechanics refresher that frames topics in a way especially

<https://www.lib.utexas.edu/>



The screenshot shows the University of Texas Libraries search results for the query "electrochemistry". The search results are displayed in a list format, showing the first four results. Each result includes a book cover, the title, author, and availability information. The search results are filtered by "Relevance" and "Show Only" is set to "Available online".

electrochemistry

To view all results please [Sign in](#) or [DISMISS](#)

Refine results

☐ Include results beyond UT

Sort by Relevance

Show Only ^

Available online

Peer-reviewed Journals

Open Access

Physical Copy

Resource Type ^

Creation Date ^

From 1767 To 2024 Refine

Library ^

Location in Library ^

Subject ^

Author/Creator ^

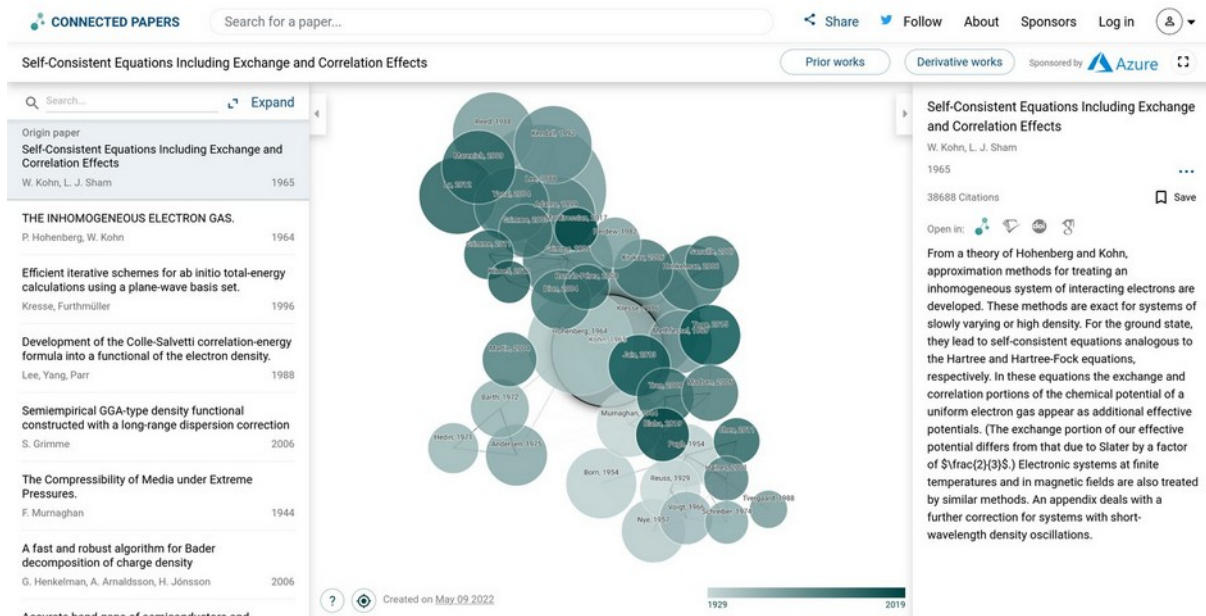
0 selected PAGE 1 522,051 Results

- BOOK
Electrochemistry. Edited by J. O'M. Bockris.
Bockris, J. O'M. (John O'M.), 1923-
1973
MTP International review of science; Physical chemistry. Series one; v. 6.
Available at Perry-Castañeda Library PCL - Chemistry Collection - PCL Stacks 6AA-BB (CHEM QD 553 E432 1973) >
- BOOK
Electrochemistry.
Rieger, P. H.
1993; 2nd ed.
Available Online >
- BOOK
Electrochemistry / Philip H. Rieger.
Rieger, Philip Henri, 1935-
c1994; 2nd ed.
Available at Perry-Castañeda Library PCL - Chemistry Collection - PCL Stacks 6AA-BB (CHEM QD 553 R53 1994) >
- BOOK
Electrochemistry. Edited by Henry Eyring.
Eyring, Henry, 1901-1981.

By no means exhaustive; add any you find!

Know the most recent literature

Know the seminal papers of the field



CONNECTED
PAPERS

<https://www.connectedpapers.com/>

- Some (pseudo)-indicators:
- Citation count
 - Journal Impact Factor
= # recent citations/# articles

CURRENT CONCEPTS REVIEW

Understanding the Limitations of the Journal Impact Factor

Kurmis, Andrew P. PhD¹

[Author Information](#) ⓘ

The Journal of Bone & Joint Surgery: December 2003 - Volume 85 - Issue 12 - p 2449-2454

Review Article | [Published: 23 December 2011](#)

Diversity, value and limitations of the journal impact factor and alternative metrics

[Lutz Bornmann](#), [Werner Marx](#), [Armen Yuri Gasparyan](#) ✉ & [George D. Kitas](#)

[Rheumatology International](#) 32, 1861–1867 (2012) | [Cite this article](#)

2204 Accesses | 106 Citations | 2 Altmetric | [Metrics](#)

 Full Text | Scholarly Journal

Journal Impact Factor: Its Use, Significance and Limitations

Sharma, Mohit; Sarin, Anurag; Gupta, Priyanka; Sachdeva, Shobhit; Desai, Ankur. *World Journal of Nuclear Medicine*; Singapore Vol. 13, Iss. 2, (May 2014).

DOI:10.4103/1450-1147.139151

Rank	Journal Publication
1.	Nature – Impact Factor: 42.78
2.	The New England Journal of Medicine – Impact Factor: 74.7
3.	Science – Impact Factor: 41.84
4.	IEEE/CVF Conference on Computer Vision and Pattern Recognition – Impact Factor: 45.17
5.	The Lancet – Impact Factor: 59.1
6.	Advanced Materials – Impact Factor: 30.85
7.	Cell – Impact Factor: 38.64
8.	Nature Communications – Impact Factor: 14.92
9.	Chemical Reviews – Impact Factor: 60.62
10.	International Conference on Learning Representations – Impact Factor: 20.03
11.	JAMA – Impact Factor: 56.27
12.	Neural Information Processing Systems – Impact Factor: 16.54
13.	Proceedings of the National Academy of Sciences – Impact Factor: 11.2
14.	Journal of the American Chemical Society – Impact Factor: 15.42
15.	Angewandte Chemie – Impact Factor: 15.34
16.	Chemical Society Reviews – Impact Factor: 54.56
17.	Nucleic Acids Research – Impact Factor: 16.97
18.	Renewable and Sustainable Energy Reviews – Impact Factor: 14.982
19.	Journal of Clinical Oncology – Impact Factor: 44.54
20.	Physical Review Letters – Impact Factor: 9.161

Be aware of the people at the forefront of the field

An efficient nickel hydrogen oxidation catalyst for hydroxide exchange membrane fuel cells

Welyan Ni^{1,6}, Teng Wang^{2,4}, Florent Héréguel¹, Anna Krammer¹, Seunghwa Lee¹, Lliang Yao⁵, Andreas Schüler⁴, Jeremy S. Luterbacher³, Yushan Yan^{2,6*} and Xile Hu^{1,6*}

The hydroxide exchange membrane fuel cell (HEMFC) is a promising energy conversion technology but is limited by the need for platinum group metal (PGM) electrocatalysts, especially for the hydrogen oxidation reaction (HOR). Here we report a Ni-based HOR catalyst that exhibits an electrochemical surface area-normalized exchange current density of $70 \mu\text{A cm}^{-2}$, the highest among PGM-free catalysts. The catalyst comprises Ni nanoparticles embedded in a nitrogen-doped carbon support. According to X-ray and ultraviolet photoelectron spectroscopy as well as H_2 chemisorption data, the electronic interaction between the Ni nanoparticles and the support leads to balanced hydrogen and hydroxide binding energies, which are the likely origin of the catalyst's high activity. PGM-free HEMFCs employing this Ni-based HOR catalyst give a peak power density of 488 mW cm^{-2} , up to 6.4 times higher than previous best-performing analogous HEMFCs. This work demonstrates the feasibility of efficient PGM-free HEMFCs.

The proton exchange membrane fuel cell (PEMFC) is an emerging clean-energy technology, however, it requires heavy usage of Pt catalysts, perfluorinated membranes and acid-tolerant stack hardware, leading to high cost¹. The hydroxide exchange membrane fuel cell (HEMFC) is potentially a cost-effective alternative to the PEMFC because less costly catalysts, membranes and stack hardware might be used in alkaline medium. One important target for the development of HEMFCs is to eliminate the need for platinum group metals (PGMs)². To date, PGM-free catalysts for the oxygen reduction reaction (ORR) at the cathode have achieved performances comparable to their PGM counterparts^{3–5}, and highly conductive and stable hydroxide exchange membranes have emerged⁶. However, there is a lack of active PGM-free catalysts for the hydrogen oxidation reaction (HOR) at the anode, representing a major barrier to the progress of HEMFCs^{7–9}. For example, HEMFCs with a PGM HOR catalyst and an Earth-abundant ORR catalyst can reach a peak power density of more than $2,500 \text{ mW cm}^{-2}$ (ref. ¹), whereas HEMFCs with both PGM-free HOR and ORR catalysts have a highest peak power density of merely 76 mW cm^{-2} (ref. ¹). As a result, the US Department of Energy (DOE) has set a peak power density target of 600 mW cm^{-2} for PGM-free HEMFCs in 2030 (ref. ¹).

HEMFCs pose challenges for HOR catalysts, not only in having a high intrinsic activity, but also in exhibiting other desirable properties, such as a large surface area, porous structure and resistance to high temperature, anodic potential and CO poisoning¹⁰. Among Earth-abundant metals, nickel proves to be the best candidate to meet these requirements. Nevertheless, state-of-the-art Ni catalysts typically exhibit intrinsic activity below $40 \mu\text{A cm}^{-2}$ per electrochemical surface area (ECSA) of the catalyst ($40 \mu\text{A cm}^{-2}$; refs. ^{11–13}). Although a few catalysts have a higher intrinsic activity, their surface areas are very small^{14–16}. Furthermore, some catalysts exhibit good mass activity in model studies involving rotating disc

electrode (RDE) measurements, but they are prone to oxidation and are unsuitable for practical devices¹⁷. In fact, the stability of nickel in a fuel cell working environment, that is, at elevated temperature and high current density, is not well demonstrated. As a result, previously reported Ni catalysts do not exhibit good performance in a complete cell configuration, especially with a PGM-free cathode. Here, we report a Ni catalyst that exhibits an intrinsic activity of $70 \mu\text{A cm}^{-2}$ per Ni ($70 \mu\text{A cm}_{\text{Ni}}^{-2}$). PGM-free HEMFCs employing this catalyst gave a peak power density of 488 mW cm^{-2} at 95°C and 443 mW cm^{-2} at 80°C , about six times higher than the previous best analogous HEMFCs. The superior activity of our catalyst is due to balanced hydrogen binding energy (HBE) and hydroxide binding energy (OHBE), resulting from a fine-tuned Ni-support interaction.

The catalyst $\text{Ni-H}_2\text{-NH}_2$ was prepared by pyrolysing a Ni-based metal-organic framework, $\text{Ni}_2(\text{BTC})_2$ (BTC, benzene-1,3,5-tricarboxylate¹⁸) at 300°C in a mixed atmosphere of $\text{H}_2/\text{NH}_3/\text{N}_2$ (4.6:33.6:61.8, v/v/v; see Materials and methods and Supplementary Figs. 1–3). NH_3 was used to introduce nitrogen doping to regulate the electronic structure of Ni (ref. ¹⁹), while H_2 was used as a reducing agent to form metallic Ni. The temperature and partial pressure of each gas were carefully optimized. Reference compounds Ni-H_2 and Ni-NH_2 were also prepared using the same method with H_2/N_2 and NH_3/N_2 ratios of 4.6:95.4 and 33.6:66.4 (v/v), respectively (Fig. 1a).

Transmission electron microscopy (TEM) showed that $\text{Ni-H}_2\text{-NH}_2$ and Ni-NH_2 contained small, separated nanoparticles with an average size of 13.3 ± 3.5 and $8.6 \pm 2.1 \text{ nm}$, respectively, whereas Ni-H_2 was composed of sintered particles with a large grain size (Fig. 1b–d and Supplementary Fig. 4). The Supplementary Notes and Supplementary Figs. 5–10 provide additional characterization data for $\text{Ni-H}_2\text{-NH}_2$, Ni-NH_2 and Ni-H_2 . High-resolution

authors

A note on authorship and author contributions:

- First few authors- listed by degree of contribution
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