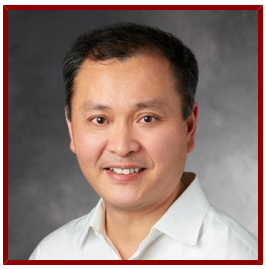
Stanford



Hongjie Dai

The J.G. Jackson and C.J. Wood Professor of Chemistry, Emeritus

CONTACT INFORMATION

- **Administrative Contact**

  Mei Yee "Maggie" Yeung - Administrative Associate

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Bio

BIO

Professor Dai's research spans chemistry, physics, and materials and biomedical sciences, leading to materials with properties useful in electronics, energy storage and biomedicine. Recent developments include near-infrared-II fluorescence imaging, ultra-sensitive diagnostic assays, a fast-charging aluminum battery and inexpensive electrocatalysts that split water into oxygen and hydrogen fuels.

Born in 1966 in Shaoyang, China, Hongjie Dai began his formal studies in physics at Tsinghua U. (B.S. 1989) and applied sciences at Columbia U. (M.S. 1991). He obtained his Ph.D. from Harvard U and performed postdoctoral research with Dr. Richard Smalley. He joined the Stanford faculty in 1997, and in 2007 was named Jackson–Wood Professor of Chemistry. Among many awards, he has been recognized with the ACS Pure Chemistry Award, APS McGroddy Prize for New Materials, Julius Springer Prize for Applied Physics and Materials Research Society Mid-Career Award. He has been elected to the American Academy of Arts and Sciences, National Academy of Sciences (NAS), National Academy of Medicine (NAM) and Foreign Member of Chinese Academy of Sciences.

The Dai Laboratory has advanced the synthesis and basic understanding of carbon nanomaterials and applications in nanoelectronics, nanomedicine, energy storage and electrocatalysis.

Nanomaterials

The Dai Lab pioneered some of the now-widespread uses of chemical vapor deposition for carbon nanotube (CNT) growth, including vertically aligned nanotubes and patterned growth of single-walled CNTs on wafer substrates, facilitating fundamental studies of their intrinsic properties. The group developed the synthesis of graphene nanoribbons, and of nanocrystals and nanoparticles on CNTs and graphene with controlled degrees of oxidation, producing a class of strongly coupled hybrid materials with advanced properties for electrochemistry, electrocatalysis and photocatalysis. The lab's synthesis of a novel plasmonic gold film has enhanced near-infrared fluorescence up to 100-fold, enabling ultra-sensitive assays of disease biomarkers.

Nanoscale Physics and Electronics

High quality nanotubes from his group's synthesis are widely used to investigate the electrical, mechanical, optical, electro-mechanical and thermal properties of quasi-one-dimensional systems. Lab members have studied ballistic electron transport in nanotubes and demonstrated nanotube-based nanosensors, Pd ohmic contacts and ballistic field effect transistors with integrated high-kappa dielectrics.

Nanomedicine and NIR-II Imaging

Advancing biological research with CNTs and nano-graphene, group members have developed π–π stacking non-covalent functionalization chemistry, molecular cellular delivery (drugs, proteins and siRNA), in vivo anti-cancer drug delivery and in vivo photothermal ablation of cancer. Using nanotubes as novel contrast agents, lab collaborations have developed in vitro and in vivo Raman, photoacoustic and fluorescence imaging. Lab members have exploited the physics of reduced light scattering in the near-infrared-II (1000-1700nm) window and pioneered NIR-II fluorescence imaging to increase tissue penetration depth in vivo. Video-rate NIR-II imaging can measure blood flow in single vessels in real time. The lab has developed novel NIR-II fluorescence agents, including CNTs, quantum dots, conjugated polymers and small organic dyes with promise for clinical translation.

Electrocatalysis and Batteries

The Dai group's nanocarbon–inorganic particle hybrid materials have opened new directions in energy research. Advances include electrocatalysts for oxygen reduction and water splitting catalysts including NiFe layered-double-hydroxide for oxygen evolution. Recently, the group also demonstrated an aluminum ion battery with graphite cathodes and ionic liquid electrolytes, a substantial breakthrough in battery science.

ACADEMIC APPOINTMENTS

- Emeritus Faculty, Acad Council, Chemistry
- Member, Bio-X
- Member, Cardiovascular Institute
- Member, Maternal & Child Health Research Institute (MCHRI)
- Member, Stanford Cancer Institute
- Member, Wu Tsai Neurosciences Institute

HONORS AND AWARDS

- Member, National Academy of Medicine (NAM) (2019)
- NIH Director's Pioneer Award, National Institute of Health (2017)
- Member, National Academy of Sciences (NAS) (2016)
- Mid-Career Researcher Award, Materials Research Society (2016)
- Honorary Chair Professor, National Taiwan University of Science and Technology (2015)
- Fellow, American Association for the Advancement of Sciences (2010)
- Fellow, American Academy of Arts and Sciences (2009)
- The Ramabrahmam and Balamani Guthikonda Award, Columbia University (2009)
- James McGroddy Prize for New Materials, American Physical Society (2006)
- Julius Springer Prize of Applied Physics, Editors of Applied Physics A and Applied Physics B, Springer (2004)
- Camille Dreyfus Teacher-Scholar Award, Camille & Henry Dreyfus Foundation (2002)
- Pure Chemistry Award, American Chemical Society (2002)
- Alfred P. Sloan Research Fellow, Alfred P. Sloan Foundation (2001)
- Packard Fellowship for Science and Engineering, David & Lucile Packard Foundation (1999)
- Terman Fellowship, Stanford University (1998)

- Young Microscopist of the Year Award, Molecular Imaging Co. (1998)
- Camille and Henry Dreyfus New Faculty Award, Rice University (1997)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Scientific Advisor and Co-founder, Nirmidas Biotech, Inc.
- Editorial Board Member, Nano Letters, American Chemical Society
- Editorial Board Member, Nano Research, Springer and Tsinghua University Press
- Editorial Board Member, Advanced Functional Materials, Wiley-VCH Verlag GmbH.
- Editorial Board Member, International Journal of Nanoscience, World Scientific, Singapore
- Editorial Board Member, Chemical Physics Letters
- Editorial Board Member, Nanotechnology, Institute of Physics, England
- Editorial Board Member, Small, Wiley-VCH Verlag
- Editorial Board Member, Applied Physics A, Springer

PROFESSIONAL EDUCATION

- Postdoc, Harvard University , Charge density waves/Superconductor (1997)
- Postdoc, Rice University , Carbon nanotubes for AFM (1995)
- PhD, Harvard University , Applied Physics/Physical Chemistry (1994)
- MS, Columbia University , Applied Sciences (1991)
- BS, TsingHua University , Physics (1989)

LINKS

- The Dai Laboratory: http://dailab.stanford.edu/

Teaching

COURSES

2022-23

- Instrumental Analysis Principles and Practice: CHEM 131 (Spr)
- Physical chemistry laboratory I: CHEM 174, CHEM 274 (Aut)

Publications

PUBLICATIONS

- **A SARS-CoV-2 vaccine on an NIR-II/SWIR emitting nanoparticle platform.** *Science advances*
  Jiang, Y., Sanyal, M., Hussein, N. A., Baghdasaryan, A., Zhang, M., Wang, F., Ren, F., Li, J., Zhu, G., Meng, Y., Adamska, J. Z., Mellins, E., Dai, et al
  2025; 11 (6): eadp5539
- **Cooperative dual single atom Ni/Cu catalyst for highly selective CO₂-to-ethanol reduction** *APPLIED CATALYSIS B-ENVIRONMENT AND ENERGY*
  Chala, S., Lakshmanan, K., Huang, W., Kahsay, A., Chang, C., Angerasa, F., Liao, Y., Lee, J., Dai, H., Tsai, M., Su, W., Hwang, B.
  2024; 358
- **A human autoimmune organoid model reveals IL-7 function in coeliac disease.** *Nature*
  Santos, A. J., van Unen, V., Lin, Z., Chirieleison, S. M., Ha, N., Batish, A., Chan, J. E., Cedano, J., Zhang, E. T., Mu, Q., Guh-Siesel, A., Tomaske, M., Colburg, et al
  2024

- **In vivo NIR-II fluorescence imaging for biology and medicine** *NATURE PHOTONICS*
  Wang, F., Zhong, Y., Bruns, O., Liang, Y., Dai, H.
  2024
- **Analysis of Si, Cu, and Their Oxides by X-ray Photoelectron Spectroscopy** *JOURNAL OF CHEMICAL EDUCATION*
  Li, J., Zhu, G., Liang, P., Dai, H.
  2024; 101 (3): 1162-1170
- **Intratumor injected gold molecular clusters for NIR-II imaging and cancer therapy.** *Proceedings of the National Academy of Sciences of the United States of America*
  Baghdasaryan, A., Liu, H., Ren, F., Hsu, R., Jiang, Y., Wang, F., Zhang, M., Grigoryan, L., Dai, H.
  2024; 121 (5): e2318265121
- **Electrochemical acetate production from high-pressure gaseous and liquid CO₂** *NATURE CATALYSIS*
  Li, J., Kuang, Y., Zhang, X., Hung, W., Chiang, C., Zhu, G., Chen, G., Wang, F., Liang, P., Dai, H.
  2023
- **Rechargeable Li/Cl2 Battery Down to -80 °C.** *Advanced materials (Deerfield Beach, Fla.)*
  Liang, P., Zhu, G., Huang, C. L., Li, Y. Y., Sun, H., Yuan, B., Wu, S. C., Li, J., Wang, F., Hwang, B. J., Dai, H.
  2023: e2307192
- **Shedding light on rechargeable Na/Cl2 battery.** *Proceedings of the National Academy of Sciences of the United States of America*
  Zhu, G., Liang, P., Huang, C. L., Wu, S. C., Huang, C. C., Li, Y. Y., Jiang, S. K., Huang, W. H., Li, J., Wang, F., Hwang, B. J., Dai, H.
  2023; 120 (39): e2310903120
- **Multiplexed discrimination of SARS-CoV-2 variants via plasmonic-enhanced fluorescence in a portable and automated device.** *Nature biomedical engineering*
  Liu, Y., Yang, Y., Wang, G., Wang, D., Shao, P., Tang, J., He, T., Zheng, J., Hu, R., Liu, Y., Xu, Z., Niu, D., Lv, et al
  2023
- **Shortwave-infrared-light-emitting probes for the in vivo tracking of cancer vaccines and the elicited immune responses.** *Nature biomedical engineering*
  Ren, F., Wang, F., Baghdasaryan, A., Li, Y., Liu, H., Hsu, R., Wang, C., Li, J., Zhong, Y., Salazar, F., Xu, C., Jiang, Y., Ma, et al
  2023
- **Seeing into deep tissue** *NATURE PHOTONICS*
  Pitruzzello, G., Dai Hongjie
  2023
- **High-Capacity Rechargeable Li/Cl2 Batteries with Graphite Positive Electrodes.** *Journal of the American Chemical Society*
  Zhu, G., Liang, P., Huang, C. L., Huang, C. C., Li, Y. Y., Wu, S. C., Li, J., Wang, F., Tian, X., Huang, W. H., Jiang, S. K., Hung, W. H., Chen, et al
  2022
- **Structural engineering of alpha-MnO2 cathode by Ag plus incorporation for high capacity aqueous zinc-ion batteries** *JOURNAL OF POWER SOURCES*
  Fenta, F., Olbasa, B., Tsai, M., Temesgen, N., Huang, W., Tekaligne, T., Nikodimos, Y., Wu, S., Su, W., Dai, H., Hwang, B.
  2022; 548
- **A Non-Flammable High-Voltage 4.7 V Anode-Free Lithium Battery.** *Advanced materials (Deerfield Beach, Fla.)*
  Liang, P., Sun, H., Huang, C., Zhu, G., Tai, H., Li, J., Wang, F., Wang, Y., Huang, C., Jiang, S., Lin, M., Li, Y., Hwang, et al
  2022: e2207361
- **Phosphorylcholine-conjugated gold-molecular clusters improve signal for Lymph Node NIR-II fluorescence imaging in preclinical cancer models.** *Nature communications*
  Baghdasaryan, A., Wang, F., Ren, F., Ma, Z., Li, J., Zhou, X., Grigoryan, L., Xu, C., Dai, H.
  2022; 13 (1): 5613
- **In vivo non-invasive confocal fluorescence imaging beyond 1,700 nm using superconducting nanowire single-photon detectors.** *Nature nanotechnology*
  Wang, F., Ren, F., Ma, Z., Qu, L., Gourgues, R., Xu, C., Baghdasaryan, A., Li, J., Zadeh, I. E., Los, J. W., Fognini, A., Qin-Dregely, J., Dai, et al

2022

- **Probing dissolved CO2(aq) in aqueous solutions for CO2 electroreduction and storage.** *Science advances*
  Li, J., Guo, J., Dai, H.
  2022; 8 (19): eabo0399
- **High-precision tumor resection down to few-cell level guided by NIR-IIb molecular fluorescence imaging.** *Proceedings of the National Academy of Sciences of the United States of America*
  Wang, F., Qu, L., Ren, F., Baghdasaryan, A., Jiang, Y., Hsu, R., Liang, P., Li, J., Zhu, G., Ma, Z., Dai, H.
  2022; 119 (15): e2123111119
- **Exploring the performance of carbonate and ether-based electrolytes for anode-free lithium metal batteries operating under various conditions** *JOURNAL OF POWER SOURCES*
  Hagos, T., Bezabh, H., Redda, H., Moges, E., Huang, W., Huang, C., Su, W., Dai, H., Hwang, B.
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- **Highly Reversible Zn Metal Anode Stabilized by Dense and Anion-Derived Passivation Layer Obtained from Concentrated Hybrid Aqueous Electrolyte** *ADVANCED FUNCTIONAL MATERIALS*
  Olbasa, B., Huang, C., Fenta, F., Jiang, S., Chala, S., Tao, H., Nikodimos, Y., Wang, C., Sheu, H., Yang, Y., Ma, T., Wu, S., Su, et al
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- **Tuning Dynamically Formed Active Phases and Catalytic Mechanisms of In Situ Electrochemically Activated Layered Double Hydroxide for Oxygen Evolution Reaction.** *ACS nano*
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  Chen, C., Lin, Y., Zhou, W., Gong, M., He, Z., Shi, F., Li, X., Wu, J., Lam, K., Wang, J., Yang, F., Zeng, Q., Guo, et al
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- **Origin of shuttle-free sulfurized polyacrylonitrile in lithium-sulfur batteries (vol 492, 229508, 2021)** *JOURNAL OF POWER SOURCES*
  Huang, C., Cheng, J., Su, W., Partovi-Azar, P., Kuo, L., Tsai, M., Lin, M., Jand, S., Chan, T., Wu, N., Kaghazchi, P., Dai, H., Bieker, et al
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- **Origin of shuttle-free sulfurized polyacrylonitrile in lithium-sulfur batteries** *JOURNAL OF POWER SOURCES*
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- **Carbon Nanotubes-Potent Carriers for Targeted Drug Delivery in Rheumatoid Arthritis.** *Pharmaceutics*
  Kofoed Andersen, C., Khatri, S., Hansen, J., Slott, S., Pavan Parvathaneni, R., Mendes, A. C., Chronakis, I. S., Hung, S., Rajasekaran, N., Ma, Z., Zhu, S., Dai, H., Mellins, et al
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  Yang, Q., Ma, H., Liang, Y., Dai, H.
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- **Selective and High Current CO2 Electro-Reduction to Multicarbon Products in Near-Neutral KCl Electrolytes.** *Journal of the American Chemical Society*
  Zhang, X., Li, J., Li, Y., Jung, Y., Kuang, Y., Zhu, G., Liang, Y., Dai, H.
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  Wang, F., Ma, Z., Zhong, Y., Salazar, F., Xu, C., Ren, F., Qu, L., Wu, A. M., Dai, H.
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Ma, Z., Wang, F., Wang, W., Zhong, Y., Dai, H.
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- **Large-Scale Inhomogeneous Fluorescence Plasmonic Silver Chips: Origin and Mechanism** *CHEM*
  Hsu, L., Yen, H., Lee, M., Sheu, Y., Chen, P., Dai, H., Chen, C.
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- **Resolving the Phase Instability of a Fluorinated Ether, Carbonate-Based Electrolyte for the Safe Operation of an Anode-Free Lithium Metal Battery** *ACS APPLIED ENERGY MATERIALS*
  Hagos, T., Hagos, T., Bezabh, H., Berhe, G., Abrha, L., Chiu, S., Huang, C., Su, W., Dai, H., Hwang, B.
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  Ma, Z., Wang, F., Zhong, Y., Salazar, F., Li, J., Zhang, M., Ren, F., Wu, A. M., Dai, H.
  2020; 132 (46): 20733-20741
- **A high-performance potassium metal battery using safe ionic liquid electrolyte.** *Proceedings of the National Academy of Sciences of the United States of America*
  Sun, H., Liang, P., Zhu, G., Hung, W. H., Li, Y., Tai, H., Huang, C., Li, J., Meng, Y., Angell, M., Wang, C., Dai, H.
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- **Electrochemical transformation reaction of Cu-MnO in aqueous rechargeable zinc-ion batteries for high performance and long cycle life** *JOURNAL OF MATERIALS CHEMISTRY A*
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  Zhang, X., Wang, Y., Gu, M., Wang, M., Zhang, Z., Pan, W., Jiang, Z., Zheng, H., Lucero, M., Wang, H., Sterbinsky, G. E., Ma, Q., Wang, et al
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- **Advancing nanomedicine with cross-link functionalized nanoparticles for rapid excretion.** *Angewandte Chemie (International ed. in English)*
  Dai, H., Ma, Z., Wang, F., Zhong, Y., Salazar, F., Li, J., Zhang, M., Ren, F., Wu, A. M.
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- **High-Rate and Long-Cycle Stability with a Dendrite-Free Zinc Anode in an Aqueous Zn-Ion Battery Using Concentrated Electrolytes** *ACS APPLIED ENERGY MATERIALS*
  Olbasa, B., Fenta, F., Chiu, S., Tsai, M., Huang, C., Jote, B., Beyene, T., Liao, Y., Wang, C., Su, W., Dai, H., Hwang, B.
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- **High-Safety and High-Energy-Density Lithium Metal Batteries in a Novel Ionic-Liquid Electrolyte.** *Advanced materials (Deerfield Beach, Fla.)*
  Sun, H., Zhu, G., Zhu, Y., Lin, M., Chen, H., Li, Y., Hung, W. H., Zhou, B., Wang, X., Bai, Y., Gu, M., Huang, C., Tai, et al
  2020: e2001741
- **A mini-review on rare-earth down-conversion nanoparticles for NIR-II imaging of biological systems.** *Nano research*
  Zhong, Y., Dai, H.
  2020; 13 (5): 1281-1294
- **A mini-review on rare-earth down-conversion nanoparticles for NIR-II imaging of biological systems** *NANO RESEARCH*
  Zhong, Y., Dai, H.
  2020
- **Hierarchical 3D Architectured Ag Nanowires Shelled with NiMn-Layered Double Hydroxide as an Efficient Bifunctional Oxygen Electrocatalyst.** *ACS nano*
  Chala, S. A., Tsai, M. C., Su, W. N., Ibrahim, K. B., Thirumalraj, B. n., Chan, T. S., Lee, J. F., Dai, H. n., Hwang, B. J.
  2020
- **Electroreduction of CO2 to Formate on a Copper-Based Electrocatalyst at High Pressures with High Energy Conversion Efficiency.** *Journal of the American Chemical Society*
  Li, J. n., Kuang, Y. n., Meng, Y. n., Tian, X. n., Hung, W. H., Zhang, X. n., Li, A. n., Xu, M. n., Zhou, W. n., Ku, C. S., Chiang, C. Y., Zhu, G. n., Guo, et al

2020

- **Quantification of antibody avidities and accurate detection of SARS-CoV-2 antibodies in serum and saliva on plasmonic substrates.** *Nature biomedical engineering*
  Liu, T. n., Hsiung, J. n., Zhao, S. n., Kost, J. n., Sreedhar, D. n., Hanson, C. V., Olson, K. n., Keare, D. n., Chang, S. T., Bliden, K. P., Gurbel, P. A., Tantry, U. S., Roche, et al
  2020
- **Diagnosis and prognosis of myocardial infarction on a plasmonic chip.** *Nature communications*
  Xu, W. n., Wang, L. n., Zhang, R. n., Sun, X. n., Huang, L. n., Su, H. n., Wei, X. n., Chen, C. C., Lou, J. n., Dai, H. n., Qian, K. n.
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- **Carbon-coated FeCo nanoparticles as sensitive magnetic-particle-imaging tracers with photothermal and magnetothermal properties.** *Nature biomedical engineering*
  Song, G. n., Kenney, M. n., Chen, Y. S., Zheng, X. n., Deng, Y. n., Chen, Z. n., Wang, S. X., Gambhir, S. S., Dai, H. n., Rao, J. n.
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  Meng, Y., Zhang, X., Hung, W., He, J., Tsai, Y., Kuang, Y., Kenney, M. J., Shyue, J., Liu, Y., Stone, K. H., Zheng, X., Suib, S. L., Lin, et al
  2019
- **Ionic Liquid Analogs of AlCl3 with Urea Derivatives as Electrolytes for Aluminum Batteries** *ADVANCED FUNCTIONAL MATERIALS*
  Angell, M., Zhu, G., Lin, M., Rong, Y., Dai, H.
  2019
- **In vivo molecular imaging for immunotherapy using ultra-bright near-infrared-IIb rare-earth nanoparticles.** *Nature biotechnology*
  Zhong, Y., Ma, Z., Wang, F., Wang, X., Yang, Y., Liu, Y., Zhao, X., Li, J., Du, H., Zhang, M., Cui, Q., Zhu, S., Sun, et al
  2019
- **Dual electrolyte additives of potassium hexafluorophosphate and tris (trimethylsilyl) phosphite for anode-free lithium metal batteries** *ELECTROCHIMICA ACTA*
  Hagos, T., Berhe, G., Hagos, T., Bezabh, H., Abrha, L., Beyene, T., Huang, C., Yang, Y., Su, W., Dai, H., Hwang, B.
  2019; 316: 52–59
- **The Nano Research Young Innovators (NR45) Awards in nanoenergy** *NANO RESEARCH*
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- **Molecular imaging in the second near-infrared window.** *Advanced functional materials*
  Wan, H., Du, H., Wang, F., Dai, H.
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- **Near-Infrared-II Molecular Dyes for Cancer Imaging and Surgery** *ADVANCED MATERIALS*
  Zhu, S., Tian, R., Antaris, A. L., Chen, X., Dai, H.
  2019; 31 (24)
- **Molecular Imaging in the Second Near-Infrared Window** *ADVANCED FUNCTIONAL MATERIALS*
  Wan, H., Du, H., Wang, F., Dai, H.
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- **An electrodeposition approach to metal/metal oxide heterostructures for active hydrogen evolution catalysts in near-neutral electrolytes** *NANO RESEARCH*
  Kenney, M. J., Huang, J., Zhu, Y., Meng, Y., Xu, M., Zhu, G., Hung, W., Kuang, Y., Lin, M., Sun, X., Zhou, W., Dai, H.
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- **Light-sheet microscopy in the near-infrared II window** *NATURE METHODS*

Wang, F., Wan, H., Ma, Z., Zhong, Y., Sun, Q., Tian, Y., Qu, L., Du, H., Zhang, M., Li, L., Ma, H., Luo, J., Liang, et al
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- **Light-sheet microscopy in the near-infrared II window.** *Nature methods*
  Wang, F., Wan, H., Ma, Z., Zhong, Y., Sun, Q., Tian, Y., Qu, L., Du, H., Zhang, M., Li, L., Ma, H., Luo, J., Liang, et al
  2019
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  Beyene, T., Bezabh, H., Weret, M., Hagos, T., Huang, C., Wang, C., Su, W., Dai, H., Hwang, B.
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- **Plasmonic gold chips for the diagnosis of Toxoplasma gondii, CMV, and rubella infections using saliva with serum detection precision** *EUROPEAN JOURNAL OF CLINICAL MICROBIOLOGY & INFECTIOUS DISEASES*
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- **Rechargeable aluminum batteries: effects of cations in ionic liquid electrolytes.** *RSC advances*
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- **Solar-driven, highly sustained splitting of seawater into hydrogen and oxygen fuels** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
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- **A general route via formamide condensation to prepare atomically dispersed metal-nitrogen-carbon electrocatalysts for energy technologies** *ENERGY & ENVIRONMENTAL SCIENCE*
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  2019
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- Precourt Institute lecture: Nanotechnology for Energy Research - Stanford Precourt Institute for Energy (September 14, 2012)
- The Washington Post: Stanford Develops Flexible, Fast-charging Aluminum Battery - The Washington Post (April 6, 2015)
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