
REFERENCES

- [1] A. Kumar, P. Daw, D. Milstein, “Homogeneous Catalysis for Sustainable Energy: Hydrogen and Methanol Economies, Fuels from Biomass, and Related Topics,” *Chemical Reviews*, 122(2022)385–441.
- [2] X. Xu, X. Zhang, J. Ji, M. Fang, M. Yang, K. Ma, Y. Gao, “Comparative Analysis of Additives for Increasing Thermal Conductivity of Phase Change Materials: A Review,” *Energy Fuels*, 36(2022)5088–5101.
- [3] N.S. Lewis, D.G. Nocera, “Powering the planet: Chemical challenges in solar energy utilization,” *Proceedings of the National Academy of Sciences*, 103(2006)15729–15735.
- [4] D.B. Pal, A. Singh, A. Bhatnagar, “A review on biomass based hydrogen production technologies,” *International Journal of Hydrogen Energy*, 47(2022)1461–1480.
- [5] P. Purohit, N.B. Parnell, Z. Klimont, L.H. Isaksson, “Achieving Paris climate goals calls for increasing ambition of the Kigali Amendment,” *Nature Climate Change*, 12(2022)339–342.
- [6] D.I.A. McKay, A. Staal, J.F. Abrams, R. Winkelmann, B. Sakschewski, S. Loriani, I. Fetzer, S.E. Cornell, J. Rockström, T.M. Lenton, “Exceeding 1.5°C global warming could trigger multiple climate tipping points,” *Science*, 377(2022)7950.
- [7] K. Bruninx, M. Ovaere, “COVID-19, Green Deal and recovery plan permanently change emissions and prices in EU ETS Phase IV,” *Nature Communications*, 13(2022)1165.
- [8] L.C.S. Rocha, P.R. Junior, G. Aquila, K. Janda, “Utility-scale energy storage systems: World condition and Brazilian perspectives,” *Journal of Energy Storage*, 52(2022)105066.
- [9] B.E. Lebrouhi, J.J. Djoupo, B. Lamrani, K. Benabdelaziz, T. Kousksou, “Global hydrogen development -A technological and geopolitical overview,” *International Journal of Hydrogen Energy*, 47(2022)7016-7048.
- [10] S. Anantharaj, S. Noda, V.R. Jothi, S. Yi, M. Driess, P.W. Menezes, “Strategies and Perspectives to Catch the Missing Pieces in Energy-Efficient Hydrogen Evolution Reaction in Alkaline Media,” *Angewandte Chemie International Edition*, 60(2021)18981–19006.
- [11] H. Yang, M. Driess, P.W. Menezes, “Self-Supported Electrocatalysts for Practical Water Electrolysis,” *Advanced Energy Materials*, 11(2021)2102074.
- [12] A. Hosseinzadeha, J.L. Zhou, X. Li, M. Afsari, A. Altaee, “Techno-economic and environmental impact assessment of hydrogen production processes using bio-waste as renewable energy resource,” *Renewable and Sustainable Energy Reviews*, 156(2022)111991.
- [13] J. Lv, J. Xie, A.G.A. Mohamed, X. Zhang, Y. Wang, “M Photoelectrochemical energy storage materials: design principles and functional devices towards direct solar to electrochemical energy storage,” *Chemical Society Reviews*, 51(2022)1511-1528.
- [14] P. Chen, T.-T. Li, Y.-B. Yang, G.-R. Li, X.-P. Gao, “Coupling aqueous zinc batteries and perovskite solar cells for simultaneous energy harvest, conversion and storage,” *Nature Communications*, 13(2022)64.
- [15] Z.P. Ifkovits, J.M. Evans, M.C. Meier, K.M. Papadantonakis, N.S. Lewis, “Decoupled electrochemical water-splitting systems: a review and perspective,” *Energy Environmental Science*, 14(2021)4740–4759.

-
-
- [16] N.Z. Muradov, T.N. Veziroğlu, “From hydrocarbon to hydrogen–carbon to hydrogen economy,” *International Journal of Hydrogen Energy*, 30(2005)225–237.
- [17] A. Ajanovic, M. Sayer, R. Haas, “The economics and the environmental benignity of different colors of hydrogen,” *International Journal of Hydrogen Energy*, 47(2022)24136–24154.
- [18] J. Song, C. Wei, Z.F. Huang, C. Liu, L. Zeng, X. Wang, Z.J. Xu, “A review on fundamentals for designing oxygen evolution electrocatalysts,” *Chemical Society Reviews*, 49(2020)2196–2214.
- [19] Z.-Y. Yu, Y. Duan, X.-Y. Feng, X. Yu, M.-R. Gao, S.-H. Yu, “Clean and Affordable Hydrogen Fuel from Alkaline Water Splitting: Past, Recent Progress, and Future Prospects,” *Advanced Materials*, 33(2021)2007100.
- [20] S. Trasatti, “N 1799–1999: Alessandro Volta’s ‘Electric Pile’ Two hundred years, but it doesn’t seem like it,” *Journal of Electroanalytical Chemistry*, 460(1999)1–4.
- [21] B. Singh, A. Singh, A. Yadav, A. Indra, “Modulating electronic structure of metal-organic framework derived catalysts for electrochemical water oxidation,” *Coordination Chemistry Reviews*, 447(2021)214144.
- [22] B. Singh, A. Indra, “Prussian blue- and Prussian blue analogue-derived materials: progress and prospects for electrochemical energy conversion,” *Materials Today Energy*, 16(2020)100404.
- [23] N. Dubouis, A. Grimaud, “The hydrogen evolution reaction: from material to interfacial descriptors,” *Chemical Science*, 10(2019)9165–9181.
- [24] J. Durst, A. Siebel, C. Simon, F. Hasché, J. Herranz, H.A. Gasteiger, “New insights into the electrochemical hydrogen oxidation and evolution reaction mechanism,” *Energy Environmental Science*, 7(2014)2255–2260.
- [25] N. Mahmood, Y. Yao, J.-W. Zhang, L. Pan, X. Zhang, J.-J. Zou, “Electrocatalysts for Hydrogen Evolution in Alkaline Electrolytes: Mechanisms, Challenges, and Prospective Solutions,” *Advanced Science*, 5(2018)1700464.
- [26] F. Dionigi, Z. Zeng, I. Sinev, T. Merzdorf, S. Deshpande, M.B. Lopez, S. Kunze, I. Zegkinoglou, H. Sarodnik, D. Fan, A. Bergmann, J. Drnec, J.F. de Araujo, M. Glieth, D. Teschner, J. Zhu, W.-X. Li, J. Greeley, B.R. Cuenya, P. Strasser, “In-situ structure and catalytic mechanism of NiFe and CoFe layered double hydroxides during oxygen evolution,” *Nature Communications*, 11(2020)2522.
- [27] X. Huang, J. Wang, H.B. Tao, H. Tian, H. Xu, “An essential descriptor for the oxygen evolution reaction on reducible metal oxide surfaces,” *Chemical Science*, 10(2019)3340–3345.
- [28] S. Dutta, Z. Liu, H. Han, A. Indra, T. Song, “Electrochemical Energy Conversion and Storage with Zeolitic Imidazolate Framework Derived Materials: A Perspective,” *ChemElectroChem*, 5(2018)3571–3588.
- [29] B. Singh, A. Indra, “Designing Self-Supported Metal-Organic Framework Derived Catalysts for Electrochemical Water Splitting,” *Chemistry -An Asian Journal*, 15(2020)607–623.
- [30] C. Walter, P.W. Menezes, M. Driess, “Perspective on intermetallics towards efficient electrocatalytic water-splitting,” *Chemical Science*, 12(2021)8603–8631.
- [31] X. Li, X. Hao, A. Abudula, G. Guan, “Nanostructured catalysts for electrochemical water splitting: current state and prospects,” *Journal of Materials Chemistry A*, 4(2016)11973–12000.
- [32] Y. Yan, B.Y. Xia, B. Zhao, X. Wang, “A review on noble-metal-free bifunctional heterogeneous catalysts for overall electrochemical water splitting,” *Journal of Materials Chemistry A*, 4(2016)17587–17603.
-
-

-
-
- [33] L. Yu, Q. Zhu, S. Song, B. McElhenny, D. Wang, C. Wu, Z. Qin, J. Bao, Y. Yu, S. Chen, Z. Ren, “Non-noble metal-nitride based electrocatalysts for high-performance alkaline seawater electrolysis,” *Nature Communications*, 10(2019)5106.
- [34] Z. Xue, Y. Li, Y. Zhang, W. Geng, B. Jia, J. Tang, S. Bao, H.-P. Wang, Y. Fan, Z. Wei, Z. Zhang, Z. Ke, G. Li, C.-Y. Su, “Modulating Electronic Structure of Metal-Organic Framework for Efficient Electrocatalytic Oxygen Evolution,” *Advanced Energy Materials*, 8(2018)1801564.
- [35] W. T. Hong, R. E. Welsch, Y. Shao-Horn, “Descriptors of Oxygen-Evolution Activity for Oxides: A Statistical Evaluation,” *Journal of Physical Chemistry C*, 120(2016)78–86.
- [36] Z. Shi, X. Wang, J. Ge, C. Liu, W. Xing, “Fundamental understanding of the acidic oxygen evolution reaction: mechanism study and state-of-the-art catalysts,” *Nanoscale*, 12(2020)13249–13275.
- [37] H. Dau, C. Limberg, T. Reier, M. Risch, S. Roggan, P. Strasser, “The Mechanism of Water Oxidation: From Electrolysis via Homogeneous to Biological Catalysis,” *ChemCatChem*, 2(2010)724–761.
- [38] A. Indra, P.W. Menezes, M. Driess, “Uncovering Structure–Activity Relationships in Manganese-Oxide-Based Heterogeneous Catalysts for Efficient Water Oxidation,” *ChemSusChem*, 8(2015)776–785.
- [39] F.A. Garcés-Pineda, M. Blasco-Ahicart, D. Nieto-Castro, N. López, J.R. Galán-Mascarós, “Direct magnetic enhancement of electrocatalytic water oxidation in alkaline media,” *Nature Energy*, 4(2019)519–525.
- [40] S. Dutta, A. Indra, Y. Feng, T. Song, U. Paik, “Self-Supported Nickel Iron Layered Double Hydroxide-Nickel Selenide Electrocatalyst for Superior Water Splitting Activity,” *ACS Applied Materials & Interfaces*, 9(2017)33766–33774.
- [41] K. Xu, P. Chen, X. Li, Y. Tong, H. Ding, X. Wu, W. Chu, Z. Peng, C. Wu, Y. Xie, “Metallic nickel nitride nanosheets realizing enhanced electrochemical water oxidation,” *Journal of American Chemical Society*, 137(2015)4119–4125.
- [42] H. Wu, W. Xiao, C. Guan, X. Liu, W. Zang, H. Zhang, J. Ding, Y.P. Feng, S.J. Pennycook, J. Wang, “Hollow Mo-doped CoP nanoarrays for efficient overall water splitting,” *Nano Energy*, 48(2018)73–80.
- [43] Z. Tao, T. Wang, X. Wang, J. Zheng, X. Li, “MOF-Derived Noble Metal Free Catalysts for Electrochemical Water Splitting,” *ACS Applied Materials & Interfaces*, 8(2016)35390–35397.
- [44] J.N. Hausmann, S. Mebs, K. Laun, I. Zebger, H. Dau, P.W. Menezes, M. Driess, “Understanding the formation of bulk- and surface-active layered (oxy)hydroxides for water oxidation starting from a cobalt selenite precursor,” *Energy Environmental Science*, 13(2020)3607–3619.
- [45] Y. Yang, Z. Lin, S. Gao, J. Su, Z. Lun, G. Xia, J. Chen, R. Zhang, Q. Chen, “Tuning Electronic Structures of Nonprecious Ternary Alloys Encapsulated in Graphene Layers for Optimizing Overall Water Splitting Activity,” *ACS Catalysis*, 7(2016)469–479.
- [46] J. Liang, X. Gao, B. Guo, Y. Ding, J. Yan, Z. Guo, E.C.M. Tse, J. Liu, “Ferrocene-Based Metal–Organic Framework Nanosheets as a Robust Oxygen Evolution Catalyst,” *Angewandte Chemie International Edition*, 60(2021)12770–12774.
- [47] J. Nai, Y. Lu, L. Yu, X. Wang, X.W. (David) Lou, “Formation of Ni–Fe Mixed Diselenide Nanocages as a Superior Oxygen Evolution Electrocatalyst,” *Advanced Materials*, 29(2017)1703870.
- [48] Z. Cai, X. Bu, P. Wang, J.C. Ho, J. Yang, X. Wang, “Recent advances in layered

-
- double hydroxide electrocatalysts for the oxygen evolution reaction,” *Journal of Materials Chemistry A*, 7(2019)5069–5089.
- [49] D. Zhou, P. Li, X. Lin, A. McKinley, Y. Kuang, W. Liu, W.F. Lin, X. Sun, X. Duan, “Layered double hydroxide-based electrocatalysts for the oxygen evolution reaction: Identification and tailoring of active sites, and superaerophobic nanoarray electrode assembly,” *Chemical Society Reviews*, 50(2021)8790–8817.
- [50] M.J. Craig, G. Coulter, E. Dolan, J. Soriano-López, E. Mates-Torres, W. Schmitt, M. García-Melchor, “Universal scaling relations for the rational design of molecular water oxidation catalysts with near-zero overpotential,” *Nature Communications*, 10(2019)4993.
- [51] H.B. Tao, Y. Xu, X. Huang, J. Chen, L. Pei, J. Zhang, J.G. Chen, B. Liu, “A General Method to Probe Oxygen Evolution Intermediates at Operating Conditions,” *Joule*, 3(2019)1498–1509.
- [52] S. Zhao, Y. Wang, J. Dong, C.T. He, H. Yin, P. An, K. Zhao, X. Zhang, C. Gao, L. Zhang, J. Lv, J. Wang, J. Zhang, A.M. Khattak, N.A. Khan, Z. Wei, J. Zhang, S. Liu, H. Zhao, Z. Tang, “Ultrathin metal-organic framework nanosheets for electrocatalytic oxygen evolution,” *Nature Energy*, 1(2016)16184.
- [53] P.M. Bodhankar, P.B. Sarawade, G. Singh, A. Vinu, D.S. Dhawale, “Recent advances in highly active nanostructured NiFe-LDH catalyst for electrochemical water splitting,” *Journal of Materials Chemistry A*, 9(2021)3180–3208.
- [54] S. Anantharaj, S.R. Ede, K. Karthick, S. Sam Sankar, K. Sangeetha, P.E. Karthik, S. Kundu, “Precision and correctness in the evaluation of electrocatalytic water splitting: revisiting activity parameters with a critical assessment,” *Energy Environmental Science*, 11(2018)744–771.
- [55] S. Anantharaj, S. Kundu, “Do the Evaluation Parameters Reflect Intrinsic Activity of Electrocatalysts in Electrochemical Water Splitting?,” *ACS Energy Letters*, 4(2019)1260–1264.
- [56] S. Anantharaj, K. Karthick, S. Kundu, “Evolution of layered double hydroxides (LDH) as high performance water oxidation electrocatalysts: A review with insights on structure, activity and mechanism,” *Materials Today Energy*, 6(2017)1–26.
- [57] S. Anantharaj, S. Rao Ede, K. Sakthikumar, K. Karthick, S. Mishra, S. Kundu, “Recent Trends and Perspectives in Electrochemical Water Splitting with an Emphasis on Sulfide, Selenide, and Phosphide Catalysts of Fe, Co, and Ni: A Review,” *ACS Catalysis*, 6(2016)8069–8097.
- [58] L. Han, J. Xu, X. Zhu, F. Yang, X. Jia, “High-performance Ni-V-Fe metal-organic framework electrocatalyst composed of integrated nanowires and nanosheets for oxygen evolution reaction,” *Materials Today Energy*, 16(2020)100419.
- [59] Z. Xue, K. Liu, Q. Liu, Y. Li, M. Li, C.Y. Su, N. Ogiwara, H. Kobayashi, H. Kitagawa, M. Liu, G. Li, “Missing-linker metal-organic frameworks for oxygen evolution reaction,” *Nature Communications*, 10(2019)5048.
- [60] C. Cao, D.-D. Ma, Q. Xu, X.-T. Wu, Q.-L. Zhu, “Semisacrificial Template Growth of Self-Supporting MOF Nanocomposite Electrode for Efficient Electrocatalytic Water Oxidation,” *Advanced Functional Materials*, 29(2019)1807418.
- [61] M. Ding, J. Chen, M. Jiang, X. Zhang, G. Wang, “Ultrathin trimetallic metal-organic framework nanosheets for highly efficient oxygen evolution reaction,” *Journal of Materials Chemistry A*, 7(2019)14163–14168.
- [62] S. Anantharaj, S. Noda, M. Driess, P.W. Menezes, “The Pitfalls of Using Potentiodynamic Polarization Curves for Tafel Analysis in Electrocatalytic Water Splitting,” *ACS Energy Letters*, 6(2021)1607–1611.
-

-
-
- [63] T. Shinagawa, A.T. Garcia-Esparza, K. Takanabe, "Insight on Tafel slopes from a microkinetic analysis of aqueous electrocatalysis for energy conversion," *Scientific Reports*, 5(2015)13801.
- [64] A. Indra, B. Singh, A. Yadav, "Realizing Electrochemical Transformation of Metal-Organic Framework Precatalyst into Metal Hydroxide-Oxy(hydroxide) Active Catalyst During Alkaline Water Oxidation," *Journal of Materials Chemistry A*, 10(2022)3843-3868.
- [65] B. Singh, A. Indra, "Tuning the properties of CoFe-layered double hydroxide by vanadium substitution for improved water splitting activity," *Dalton Transactions*, 50(2021)2359-2363.
- [66] Z. Li, Z. Jiang, W. Zhu, C. He, P. Wang, X. Wang, T. Li, L. Tian, "Facile preparation of CoSe₂ nano-vesicle derived from ZIF-67 and their application for efficient water oxidation," *Applied Surface Science*, 504(2020)144368.
- [67] A. Indra, P.W. Menezes, N.R. Sahraie, A. Bergmann, C. Das, M. Tallarida, D. Schmeißer, P. Strasser, M. Driess, "Unification of catalytic water oxidation and oxygen reduction reactions: Amorphous beat crystalline cobalt iron oxides," *Journal of Americal Chemical Society* 136(2014)17530-17536.
- [68] L. Ding, K. Li, Z. Xie, G. Yang, S. Yu, W. Wang, H. Yu, J. Baxter, H.M. Meyer, D.A. Cullen, F.Y. Zhang, "Constructing Ultrathin W-Doped NiFe Nanosheets via Facile Electrosynthesis as Bifunctional Electrocatalysts for Efficient Water Splitting," *ACS Applied Materials & Interfaces*, 13(2021)20070-20080.
- [69] B. Mohanty, P. Bhanja, B.K. Jena, "An Overview on advances in Design and Development of Materials for electrochemical generation of Hydrogen and Oxygen," *Materials Today Energy*, 23(2021)100902.
- [70] J. Mohammed-ibrahim, H. Moussab, "Tuning the electronic structure of the earth-abundant electrocatalysts for oxygen evolution reaction (OER) to achieve efficient alkaline water splitting – A review," *Journal of Energy Chemistry*, 56(2021)299-342.
- [71] H. Liu, D. Guo, W. Zhang, R. Cao, "Co(OH)₂ hollow nanoflowers as highly efficient electrocatalysts for oxygen evolution reaction," *Journal of Materials Research*, 33(2018)568-580.
- [72] J. Cheng, H. Zhang, G. Chen, Y. Zhang, "Study of Ir_xRu_{1-x}O₂ oxides as anodic electrocatalysts for solid polymer electrolyte water electrolysis," *Electrochimica Acta*, 54(2009)6250-6256.
- [73] E. Fabbrì, A. Haberer, K. Waltar, R. Kötz, T.J. Schmidt, "Developments and perspectives of oxide-based catalysts for the oxygen evolution reaction," *Catalysis Science & Technology*, 4(2014)3800-3821.
- [74] W. Li, F. Li, H. Yang, X. Wu, P. Zhang, Y. Shan, L. Sun, "A bio-inspired coordination polymer as outstanding water oxidation catalyst via second coordination sphere engineering," *Nature Communications*, 10(2019)5074.
- [75] Y. Shen, S.-G. Guo, F. Du, X.-B. Yuan, Y. Zhang, J. Hu, Q. Shen, W. Luo, A. Alsaedi, T. Hayat, G. Wen, G.-L. Li, Y. Zhou, Z. Zou, "Prussian blue analogue-derived Ni and Co bimetallic oxide nanoplate arrays block-built from porous and hollow nanocubes for the efficient oxygen evolution reaction," *Nanoscale*, 11(2019)11765-11773.
- [76] C. Li, Y. Liu, L. Guan, K. Li, G. Wang, Y. Lin, "Understanding coordination modification strategy on metal organic framework-based system for efficient water oxidation," *Chemical Engineering Journal*, 400(2020)125884.
- [77] Q. Zhao, Z. Yan, C. Chen, J. Chen, "Spinels: Controlled Preparation, Oxygen Reduction/Evolution Reaction Application, and beyond," *Chemical Reviews*,

-
- 117(2017)10121–10211.
- [78] Y. Wang, J. Tang, B. Kong, D. Jia, Y. Wang, T. An, L. Zhang, G. Zheng, “Freestanding 3D graphene/cobalt sulfide composites for supercapacitors and hydrogen evolution reaction,” *RSC Advances*, 5(2015)6886–6891.
- [79] T. Binninger, E. Fabbri, R. Kötz, T.J. Schmidt, “Determination of the Electrochemically Active Surface Area of Metal-Oxide Supported Platinum Catalyst,” *Journal of The Electrochemical Society*, 161(2013)H121–H128.
- [80] A.T. Marshall, R.G. Haverkamp, “Electrocatalytic activity of IrO₂–RuO₂ supported on Sb-doped SnO₂ nanoparticles,” *Electrochimica Acta*, 55(2010)1978–1984.
- [81] A. Indra, U. Paik, T. Song, “Boosting Electrochemical Water Oxidation with Metal Hydroxide Carbonate Templated Prussian Blue Analogues,” *Angewandte Chemie International Edition*, 57(2018)1241–1245.
- [82] B. Singh, O. Prakash, P. Maiti, P.W. Menezes, “A. Indra, Electrochemical transformation of Prussian blue analogues into ultrathin layered double hydroxide nanosheets for water splitting,” *Chemical Communications*, 56(2020)15036–15039.
- [83] K. Karthick, S. Anantharaj, P.E. Karthik, B. Subramanian, S. Kundu, “Self-Assembled Molecular Hybrids of CoS-DNA for Enhanced Water Oxidation with Low Cobalt Content,” *Inorganic Chemistry*, 56(2017)6734–6745.
- [84] A.K. Singh, S. Ji, B. Singh, C. Das, H. Choi, P.W. Menezes, A. Indra, “Alkaline oxygen evolution: exploring synergy between fcc and hcp cobalt nanoparticles entrapped in N-doped graphene,” *Materials Today Chemistry*, 23(2022)100668.
- [85] S. Dey, B. Singh, S. Dasgupta, A. Dutta, A. Indra, G.K. Lahiri, “Ruthenium–Benzothiadiazole Building Block Derived Dynamic Heterometallic Ru–Ag Coordination Polymer and Its Enhanced Water-Splitting Feature,” *Inorganic Chemistry*, 60(2021)9607–9620.
- [86] S. Kumar Pal, B. Singh, J.K. Yadav, C.L. Yadav, M.G.B. Drew, N. Singh, A. Indra, K. Kumar, “Homoleptic Ni(ii) dithiocarbamate complexes as pre-catalysts for the electrocatalytic oxygen evolution reaction,” *Dalton Transactions*, 51(2022)13003–13014.
- [87] S. Anantharaj, P.E. Karthik, S. Kundu, “Self-assembled IrO₂ nanoparticles on a DNA scaffold with enhanced catalytic and oxygen evolution reaction (OER) activities,” *Journal of Materials Chemistry A*, 3(2015)24463–24478.
- [88] S. Anantharaj, M. Jayachandran, S. Kundu, “Unprotected and interconnected Ru⁰ nano-chain networks: advantages of unprotected surfaces in catalysis and electrocatalysis,” *Chemical Science*, 7(2016)3188–3205.
- [89] M. Görlin, P. Chernev, J. Ferreira de Araújo, T. Reier, S. Dresch, B. Paul, R. Krähnert, H. Dau, P. Strasser, “Oxygen Evolution Reaction Dynamics, Faradaic Charge Efficiency, and the Active Metal Redox States of Ni–Fe Oxide Water Splitting Electrocatalysts,” *Journal of American Chemical Society*, 138(2016)5603–5614.
- [90] X. Tan, C. Yu, C. Zhao, H. Huang, X. Yao, X. Han, W. Guo, S. Cui, H. Huang, J. Qiu, “Restructuring of Cu₂O to Cu₂O@Cu-Metal-Organic Frameworks for Selective Electrochemical Reduction of CO₂,” *ACS Applied Materials & Interfaces*, 11(2019)9904–9910.
- [91] S. Anantharaj, P.E. Karthik, S. Kundu, “Petal-like hierarchical array of ultrathin Ni(OH)₂ nanosheets decorated with Ni(OH)₂ nanoburles: a highly efficient OER electrocatalyst,” *Catalysis Science & Technology*, 7(2017)882–893.
- [92] K. Ye, Z. Zhou, J. Shao, L. Lin, D. Gao, N. Ta, R. Si, G. Wang, X. Bao, “In Situ Reconstruction of a Hierarchical Sn-Cu/SnO_x Core/Shell Catalyst for High-

-
- Performance CO₂ Electroreduction,” *Angewandte Chemie International Edition*, 59(2020)4814–4821.
- [93] N. Zaman, T. Noor, N. Iqbal, “Recent advances in the metal-organic framework-based electrocatalysts for the hydrogen evolution reaction in water splitting: a review,” *RSC Advances*, 11(2021)21904–21925.
- [94] C. Li, J.-B. Baek, “Recent Advances in Noble Metal (Pt, Ru, and Ir)-Based Electrocatalysts for Efficient Hydrogen Evolution Reaction,” *ACS Omega*, 5(2019)31–40.
- [95] C.-J. Chang, Y.-C. Chu, H.-Y. Yan, Y.-F. Liao, H.M. Chen, “Revealing the structural transformation of rutile RuO₂ via in situ X-ray absorption spectroscopy during the oxygen evolution reaction,” *Dalton Transactions*, 48(2019)7122–7129.
- [96] T. Audichon, T. W. Napporn, C. Canaff, C. Morais, C. Comminges, K. Boniface Kokoh, “IrO₂ Coated on RuO₂ as Efficient and Stable Electroactive Nanocatalysts for Electrochemical Water Splitting,” *Journal of Physical Chemistry C*, 120(2016)2562–2573.
- [97] Y. Lattach, J. Francisco Rivera, T. Bamine, A. Deronzier, J.-C. Moutet, “Iridium Oxide–Polymer Nanocomposite Electrode Materials for Water Oxidation,” *ACS Applied Materials & Interfaces*, 6(2014)12852–12859.
- [98] O. Diaz-Morales, S. Raaijman, R. Kortlever, P.J. Kooyman, T. Wezendonk, J. Gascon, W.T. Fu, M.T.M. Koper, “Iridium-based double perovskites for efficient water oxidation in acid media,” *Nature Communications*, 7(2016)12363.
- [99] T. Zhang, S.-A. Liao, L.-X. Dai, J.-W. Yu, W. Zhu, Y.-W. Zhang, “Ir-Pd nanoalloys with enhanced surface-microstructure-sensitive catalytic activity for oxygen evolution reaction in acidic and alkaline media,” *Science China Materials*, 61(2018)926–938.
- [100] T. Reier, M. Oezaslan, P. Strasser, “Electrocatalytic Oxygen Evolution Reaction (OER) on Ru, Ir, and Pt Catalysts: A Comparative Study of Nanoparticles and Bulk Materials,” *ACS Catalysis*, 2(2012)1765–1772.
- [101] Z. Pu, T. Liu, G. Zhang, H. Ranganathan, Z. Chen, S. Sun, “Electrocatalytic Oxygen Evolution Reaction in Acidic Conditions: Recent Progress and Perspectives,” *ChemSusChem*, 14(2021)4636–4657.
- [102] B. Chakraborty, A. Indra, P. V. Menezes, M. Driess, P.W. Menezes, “Improved chemical water oxidation with Zn in the tetrahedral site of spinel-type ZnCo₂O₄ nanostructure,” *Materials Today Chemistry*, 15(2020)100226.
- [103] A. Indra, P.W. Menezes, C. Das, C. Göbel, M. Tallarida, D. Schmeißer, M. Driess, “A facile corrosion approach to the synthesis of highly active CoO_x water oxidation catalysts,” *Journal of Materials Chemistry A*, 5(2017)5171–5177.
- [104] P.W. Menezes, A. Indra, A. Bergmann, P. Chernev, C. Walter, H. Dau, P. Strasser, M. Driess, “Uncovering the prominent role of metal ions in octahedral versus tetrahedral sites of cobalt–zinc oxide catalysts for efficient oxidation of water,” *Journal of Materials Chemistry A*, 4(2016)10014–10022.
- [105] A. Bergmann, E. Martinez-Moreno, D. Teschner, P. Chernev, M. Gliech, J.F. De Araújo, T. Reier, H. Dau, P. Strasser, “Reversible amorphization and the catalytically active state of crystalline Co₃O₄ during oxygen evolution,” *Nature Communications*, 6(2015)8625.
- [106] D. González-Flores, I. Sánchez, I. Zaharieva, K. Klingan, J. Heidkamp, P. Chernev, P.W. Menezes, M. Driess, H. Dau, M.L. Montero, “Heterogeneous water oxidation: Surface activity versus amorphization activation in cobalt phosphate catalyst,” *Angewandte Chemie International Edition*, 54(2015)2472–2476.
- [107] B. Singh, A. Indra, “Surface and interface engineering in transition metal-based

-
-
- catalysts for electrochemical water oxidation,” *Materials Today Chemistry*, 16(2020)100239.
- [108] X. Long, Z. Wang, S. Xiao, Y. An, S. Yang, “Transition metal based layered double hydroxides tailored for energy conversion and storage,” *Materials Today*, 19(2016)213–226.
- [109] J. Song, C. Zhu, B.Z. Xu, S. Fu, M.H. Engelhard, R. Ye, D. Du, S.P. Beckman, Y. Lin, “Bimetallic Cobalt-Based Phosphide Zeolitic Imidazolate Framework: CoP_x Phase-Dependent Electrical Conductivity and Hydrogen Atom Adsorption Energy for Efficient Overall Water Splitting,” *Advanced Energy Materials*, 7(2017)1601555.
- [110] J. Yu, T.A. Le, N.Q. Tran, H. Lee, “Earth-Abundant Transition-Metal-Based Bifunctional Electrocatalysts for Overall Water Splitting in Alkaline Media,” *Chemistry – A European Journal*, 26(2020)6423–6436.
- [111] S. Sanati, A. Morsali, H. Garcia, “First-row transition metal-based materials derived from bimetallic metal-organic frameworks as highly efficient electrocatalysts for electrochemical water splitting,” *Energy Environmental Science*, 15(2022)3119-3151.
- [112] M.-Q. Yang, J. Wang, H. Wu, G.W. Ho, “Noble Metal-Free Nanocatalysts with Vacancies for Electrochemical Water Splitting,” *Small*, 14(2018)1703323.
- [113] G. Yilmaz, S.B. Peh, D. Zhao, G.W. Ho, “Atomic- and Molecular-Level Design of Functional Metal–Organic Frameworks (MOFs) and Derivatives for Energy and Environmental Applications,” *Advanced Science*, 6(2019)1901129.
- [114] Z. Chen, X. Duan, W. Wei, S. Wang, B.-J. Ni, “Recent advances in transition metal-based electrocatalysts for alkaline hydrogen evolution,” *Journal of Materials Chemistry A*, 7(2019)14971–15005.
- [115] J. Wang, X. Yue, Y. Yang, S. Sirisomboonchai, P. Wang, X. Ma, A. Abudula, G. Guan, “Earth-abundant transition-metal-based bifunctional catalysts for overall electrochemical water splitting: A review,” *Journal of Alloys and Compounds*, 819(2020)153346.
- [116] P.W. Menezes, A. Indra, P. Littlewood, M. Schwarze, C. Göbel, R. Schomäcker, M. Driess, “Nanostructured Manganese Oxides as Highly Active Water Oxidation Catalysts: A Boost from Manganese Precursor Chemistry,” *ChemSusChem*, 7(2014)2202–2211.
- [117] Y. Zhou, S. Sun, C. Wei, Y. Sun, P. Xi, Z. Feng, Z.J. Xu, “Significance of Engineering the Octahedral Units to Promote the Oxygen Evolution Reaction of Spinel Oxides,” *Advanced Materials*, 31(2019)1902509.
- [118] R.D.L. Smith, C. Pasquini, S. Loos, P. Chernev, K. Klingan, P. Kubella, M.R. Mohammadi, D. Gonzalez-Flores, H. Dau, “Spectroscopic identification of active sites for the oxygen evolution reaction on iron-cobalt oxides,” *Nature Communications*, 8(2022)2017.
- [119] D. Chen, C. Chen, Z. Medina Baiyee, Z. Shao, F. Ciucci, “Nonstoichiometric Oxides as Low-Cost and Highly-Efficient Oxygen Reduction/Evolution Catalysts for Low-Temperature Electrochemical Devices,” *Chemical Reviews*, 115(2015)9869–9921.
- [120] Y. Zhou, S. Sun, J. Song, S. Xi, B. Chen, Y. Du, A.C. Fisher, F. Cheng, X. Wang, H. Zhang, Z.J. Xu, “Enlarged Co-O Covalency in Octahedral Sites Leading to Highly Efficient Spinel Oxides for Oxygen Evolution Reaction,” *Advanced Materials*, 30(2018)1802912.
- [121] Y. Matsumoto, E. Sato, “Electrocatalytic properties of transition metal oxides for oxygen evolution reaction,” *Materials Chemistry and Physics*, 14(1986)397–426.
-
-

-
-
- [122] Z. Wang, W. Liu, Y. Hu, L. Xu, M. Guan, J. Qiu, Y. Huang, J. Bao, H. Li, "An Fe-doped NiV LDH ultrathin nanosheet as a highly efficient electrocatalyst for efficient water oxidation," *Inorganic Chemistry Frontiers*, 6(2019)1890–1896.
- [123] H. Sun, W. Zhang, J.G. Li, Z. Li, X. Ao, K.H. Xue, K.K. Ostrikov, J. Tang, C. Wang, "Rh-engineered ultrathin NiFe-LDH nanosheets enable highly-efficient overall water splitting and urea electrolysis," *Applied Catalysis B: Environmental*, 284(2021)119740.
- [124] G. Zhao, B. Wang, Q. Yan, X. Xia, "Mo-doping-assisted electrochemical transformation to generate CoFe LDH as the highly efficient electrocatalyst for overall water splitting," *Journal of Alloys and Compounds*, 902(2022)163738.
- [125] H. Yang, S. Luo, Y. Bao, Y. Luo, J. Jin, J. Ma, "In situ growth of ultrathin Ni–Fe LDH nanosheets for high performance oxygen evolution reaction," *Inorganic Chemistry Frontiers*, 4(2017)1173–1181.
- [126] H. Yi, S. Liu, C. Lai, G. Zeng, M. Li, X. Liu, B. Li, X. Huo, L. Qin, L. Li, M. Zhang, Y. Fu, Z. An, L. Chen, "Recent Advance of Transition-Metal-Based Layered Double Hydroxide Nanosheets: Synthesis, Properties, Modification, and Electrocatalytic Applications," *Advanced Energy Materials*, 11(2021)2002863.
- [127] H. Xu, B. Wang, C. Shan, P. Xi, W. Liu, Y. Tang, "Ce-Doped NiFe-Layered Double Hydroxide Ultrathin Nanosheets/Nanocarbon Hierarchical Nanocomposite as an Efficient Oxygen Evolution Catalyst," *ACS Applied Materials & Interfaces*, 10(2018)6336–6345.
- [128] S. Pan, B. Li, J. Yu, L. Zhao, Y. Zhang, "Composition controllable fabrication of ultrathin 2D CoMn layered double hydroxides for highly efficient electrocatalytic oxygen evolution," *Applied Surface Science*, 539(2021)148305.
- [129] X. Wang, L. Chai, J. Ding, L. Zhong, Y. Du, T.T. Li, Y. Hu, J. Qian, S. Huang, "Chemical and morphological transformation of MOF-derived bimetallic phosphide for efficient oxygen evolution," *Nano Energy*, 62(2019)745–753.
- [130] M. Wang, C.-L. Dong, Y.-C. Huang, Y. Li, S. Shen, "Electronic Structure Evolution in Tricomponent Metal Phosphides with Reduced Activation Energy for Efficient Electrocatalytic Oxygen Evolution," *Small*, 14(2018)1801756.
- [131] P. Wang, F. Song, R. Amal, Y.H. Ng, X. Hu, "Efficient Water Splitting Catalyzed by Cobalt Phosphide-Based Nanoneedle Arrays Supported on Carbon Cloth," *ChemSusChem*, 9(2016)472–477.
- [132] P. W. Menezes, A. Indra, C. Das, C. Walter, C. Göbel, V. Gutkin, D. Schmeißer, M. Driess, "Uncovering the Nature of Active Species of Nickel Phosphide Catalysts in High-Performance Electrochemical Overall Water Splitting," *ACS Catalysis*, 7(2016)103–109.
- [133] K. Fan, H. Zou, Y. Lu, H. Chen, F. Li, J. Liu, L. Sun, L. Tong, M. F. Toney, M. Sui, J. Yu, "Direct Observation of Structural Evolution of Metal Chalcogenide in Electrocatalytic Water Oxidation," *ACS Nano*, 12(2018)12369–12379.
- [134] J. Huang, Y. Jiang, T. An, M. Cao, "Increasing the active sites and intrinsic activity of transition metal chalcogenide electrocatalysts for enhanced water splitting," *Journal of Materials Chemistry A*, 8(2020)25465–25498.
- [135] M.I. Jamesh, X. Sun, "Recent progress on earth abundant electrocatalysts for oxygen evolution reaction (OER) in alkaline medium to achieve efficient water splitting –A review," *Journal of Power Sources*, 400(2018)31–68.
- [136] Z. Kou, X. Li, L. Zhang, W. Zang, X. Gao, J. Wang, "Dynamic Surface Chemistry of Catalysts in Oxygen Evolution Reaction," *Small Science*, 1(2021)2100011.
- [137] X. Liu, K. Ni, B. Wen, R. Guo, C. Niu, J. Meng, Q. Li, P. Wu, Y. Zhu, X. Wu, L. Mai, "Deep Reconstruction of Nickel-Based Precatalysts for Water Oxidation

-
- Catalysis,” *ACS Energy Letters*, 4(2019)2585–2592.
- [138] H. Jiang, Q. He, X. Li, X. Su, Y. Zhang, S. Chen, S. Zhang, G. Zhang, J. Jiang, Y. Luo, P.M. Ajayan, L. Song, “Tracking Structural Self-Reconstruction and Identifying True Active Sites toward Cobalt Oxide Precatalyst of Oxygen Evolution Reaction,” *Advanced Materials*, 31(2019)1805127.
- [139] W. Zheng, L. Yoon Suk Lee, “Metal–Organic Frameworks for Electrocatalysis: Catalyst or Precatalyst?,” *ACS Energy Letters*, 6(2021)2838–2843.
- [140] Y. Duan, J.Y. Lee, S. Xi, Y. Sun, J. Ge, S.J.H. Ong, Y. Chen, S. Dou, F. Meng, C. Diao, A.C. Fisher, X. Wang, G.G. Scherer, A. Grimaud, Z.J. Xu, “Anodic Oxidation Enabled Cation Leaching for Promoting Surface Reconstruction in Water Oxidation,” *Angewandte Chemie International Edition*, 60(2021)7418–7425.
- [141] Z. Chen, R. Zheng, M. Graś, W. Wei, G. Lota, H. Chen, B.J. Ni, “Tuning electronic property and surface reconstruction of amorphous iron borides via W-P co-doping for highly efficient oxygen evolution,” *Applied Catalysis B: Environmental*, 288(2021)120037.
- [142] Y. Li, X. Du, J. Huang, C. Wu, Y. Sun, G. Zou, C. Yang, J. Xiong, “Recent Progress on Surface Reconstruction of Earth-Abundant Electrocatalysts for Water Oxidation,” *Small*, 15(2019)1901980.
- [143] W. Zou, C. Sun, K. Zhao, J. Li, X. Pan, D. Ye, Y. Xie, W. Xu, H. Zhao, L. Zhang, J. Zhang, “Surface reconstruction of NiCoP pre-catalysts for bifunctional water splitting in alkaline electrolyte,” *Electrochimica Acta*, 345(2020)136114.
- [144] H. Sun, Y. Zhu, W. Jung, “Tuning Reconstruction Level of Precatalysts to Design Advanced Oxygen Evolution Electrocatalysts,” *Molecules*, 26(2021)5476.
- [145] C. Hu, L. Zhang, J. Gong, “Recent progress made in the mechanism comprehension and design of electrocatalysts for alkaline water splitting,” *Energy Environmental Science*, 12(2019)2620–2645.
- [146] S. Chen, L. Ma, Z. Huang, G. Liang, C. Zhi, “In situ/operando analysis of surface reconstruction of transition metal-based oxygen evolution electrocatalysts,” *Cell Reports Physical Science*, 7(2022)100729.
- [147] P.W. Menezes, A. Indra, N.R. Sahraie, A. Bergmann, P. Strasser, M. Driess, “Cobalt–Manganese-Based Spinels as Multifunctional Materials that Unify Catalytic Water Oxidation and Oxygen Reduction Reactions,” *ChemSusChem*, 8(2015)164–171.
- [148] A. Indra, P.W. Menezes, I. Zaharieva, H. Dau, M. Driess, “Detecting structural transformation of cobalt phosphonate to active bifunctional catalysts for electrochemical water-splitting,” *Journal of Materials Chemistry A*, 8(2020)2637–2643.
- [149] P.W. Menezes, A. Indra, O. Levy, K. Kailasam, V. Gutkin, J. Pfrommer, M. Driess, “Using nickel manganese oxide catalysts for efficient water oxidation,” *Chemical Communications*, 51(2015)521–5008.
- [150] S. Dutta, A. Indra, Y. Feng, H. Han, T. Song, “Promoting electrocatalytic overall water splitting with nanohybrid of transition metal nitride-oxynitride,” *Applied Catalysis B: Environmental*, 241(2019)521–527.
- [151] A. Indra, P.W. Menezes, C. Das, D. Schmeißer, M. Driess, “Alkaline electrochemical water oxidation with multi-shelled cobalt manganese oxide hollow spheres,” *Chemical Communications*, 53(2017)8641–8644.
- [152] P.W. Menezes, A. Indra, I. Zaharieva, C. Walter, S. Loos, S. Hoffmann, R. Schlögl, H. Dau, M. Driess, “Helical cobalt borophosphates to master durable overall water-splitting,” *Energy Environmental Science*, 12(2019)988–999.
-

-
-
- [153] D. Liu, H. Ai, J. Li, M. Fang, M. Chen, D. Liu, X. Du, P. Zhou, F. Li, K.H. Lo, Y. Tang, S. Chen, L. Wang, G. Xing, H. Pan, "Surface Reconstruction and Phase Transition on Vanadium–Cobalt–Iron Trimetal Nitrides to Form Active Oxyhydroxide for Enhanced Electrocatalytic Water Oxidation," *Advanced Energy Materials*, 10(2020)2002464.
- [154] W. Shen, J. Yin, J. Jin, Y. Hu, Y. Hou, J. Xiao, Y.-Q. Zhao, P. Xi, "Progress in In Situ Research on Dynamic Surface Reconstruction of Electrocatalysts for Oxygen Evolution Reaction," *Advanced Energy & Sustainability Research*, 3(2022)2200036.
- [155] Y. Zhao, N. Dongfang, C.A. Triana, C. Huang, R. Erni, W. Wan, J. Li, D. Stoian, L. Pan, P. Zhang, J. Lan, M. Iannuzzi, G.R. Patzke, "Dynamics and control of active sites in hierarchically nanostructured cobalt phosphide/chalcogenide-based electrocatalysts for water splitting," *Energy Environmental Science*, 15(2022)727–739.
- [156] J. Wang, S.-J. Kim, J. Liu, Y. Gao, S. Choi, J. Han, H. Shin, S. Jo, J. Kim, F. Ciucci, H. Kim, Q. Li, W. Yang, X. Long, S. Yang, S.-P. Cho, K.H. Chae, M.G. Kim, H. Kim, J. Lim, "Redirecting dynamic surface restructuring of a layered transition metal oxide catalyst for superior water oxidation," *Nature Catalysis*, 4(2021)212–222.
- [157] C. Fan, X. Wu, M. Li, X. Wang, Y. Zhu, G. Fu, T. Ma, Y. Tang, "Surface chemical reconstruction of hierarchical hollow inverse-spinel manganese cobalt oxide boosting oxygen evolution reaction," *Chemical Engineering Journal*, 431(2022)133829.
- [158] A. Sivanantham, P. Ganesan, A.V. Vinu, S. Shanmugam, "Surface Activation and Reconstruction of Non-Oxide-Based Catalysts Through in Situ Electrochemical Tuning for Oxygen Evolution Reactions in Alkaline Media," *ACS Catalysis*, 10(2020) 463–493.
- [159] C. Pan, Z. Liu, M. Huang, "2D iron-doped nickel MOF nanosheets grown on nickel foam for highly efficient oxygen evolution reaction," *Applied Surface Science*, 529(2020)147201.
- [160] M. Lou Lindstrom, R. Gakhar, K. Raja, D. Chidambaram, "Facile Synthesis of an Efficient Ni–Fe–Co Based Oxygen Evolution Reaction Electrocatalyst," *Journal of The Electrochemical Society*, 167(2020)046507.
- [161] P.W. Menezes, A. Indra, V. Gutkin, M. Driess, "Boosting electrochemical water oxidation through replacement of O_h Co sites in cobalt oxide spinel with manganese," *Chemical Communications*, 53(2017)8018–8021.
- [162] L. Gao, X. Cui, C.D. Sewell, J. Li, Z. Lin, "Recent advances in activating surface reconstruction for the high-efficiency oxygen evolution reaction," *Chemical Society Reviews*, 50(2021)8428–8469.
- [163] X. Liu, J. Meng, J. Zhu, M. Huang, B. Wen, R. Guo, L. Mai, "Comprehensive Understandings into Complete Reconstruction of Precatalysts: Synthesis, Applications, and Characterizations," *Advanced Materials*, 33(2021)2007344.
- [164] Z.-Y. Yu, Y. Duan, J.-D. Liu, Y. Chen, X.-K. Liu, W. Liu, T. Ma, Y. Li, X.-S. Zheng, T. Yao, M.-R. Gao, J.-F. Zhu, B.-J. Ye, S.-H. Yu, "Unconventional CN vacancies suppress iron-leaching in Prussian blue analogue pre-catalyst for boosted oxygen evolution catalysis," *Nature Communications*, 10(2019)2799.
- [165] D. Guan, G. Ryu, Z. Hu, J. Zhou, C.L. Dong, Y.C. Huang, K. Zhang, Y. Zhong, A.C. Komarek, M. Zhu, X. Wu, C.W. Pao, C.K. Chang, H.J. Lin, C. Te Chen, W. Zhou, Z. Shao, "Utilizing ion leaching effects for achieving high oxygen-evolving performance on hybrid nanocomposite with self-optimized behaviors," *Nature*

-
- Communications*, 11(2020)3376.
- [166] W. Da Silva Freitas, A. D'Epifanio, B. Mecheri, "Electrocatalytic CO₂ reduction on nanostructured metal-based materials: Challenges and constraints for a sustainable pathway to decarbonization," *Journal of CO₂ Utilization*, 50(2021)101579.
- [167] X. Yang, J. Chen, Y. Chen, P. Feng, H. Lai, J. Li, X. Luo, "Novel CO₃O₄ nanoparticles/nitrogen-doped carbon composites with extraordinary catalytic activity for oxygen evolution reaction (OER)," *Nano-Micro Letters*, 10(2018)1–11.
- [168] C. Chen, Y. Kang, Z. Huo, Z. Zhu, W. Huang, H.L. Xin, J.D. Snyder, D. Li, J.A. Herron, M. Mavrikakis, M. Chi, K.L. More, Y. Li, N.M. Markovic, G.A. Somorjai, P. Yang, V.R. Stamenkovic, "Highly crystalline multimetallic nanoframes with three-dimensional electrocatalytic surfaces," *Science*, 343(2014)1339–1343.
- [169] L. Huang, G. Gao, H. Zhang, J. Chen, Y. Fang, S. Dong, "Self-dissociation-assembly of ultrathin metal-organic framework nanosheet arrays for efficient oxygen evolution," *Nano Energy*, 68(2020)104296.
- [170] K. Zhu, F. Shi, X. Zhu, W. Yang, "The roles of oxygen vacancies in electrocatalytic oxygen evolution reaction," *Nano Energy*, 73(2020)104761.
- [171] J. Wang, Y. Gao, H. Kong, J. Kim, S. Choi, F. Ciucci, Y. Hao, S. Yang, Z. Shao, J. Lim, "Non-precious-metal catalysts for alkaline water electrolysis: operando characterizations, theoretical calculations, and recent advances," *Chemical Society Reviews*, 49(2020) 9154–9196.
- [172] N. Zhang, X. Feng, D. Rao, X. Deng, L. Cai, B. Qiu, R. Long, Y. Xiong, Y. Lu, Y. Chai, "Lattice oxygen activation enabled by high-valence metal sites for enhanced water oxidation," *Nature Communications*, 11(2020)4066.
- [173] K. Xu, H. Ding, H. Lv, S. Tao, P. Chen, X. Wu, W. Chu, C. Wu, Y. Xie, "Understanding Structure-Dependent Catalytic Performance of Nickel Selenides for Electrochemical Water Oxidation," *ACS Catalysis*, 7(2017)310–315.
- [174] E. Fabbri, R. Mohamed, P. Levecque, O. Conrad, R. Kötz, T. J. Schmidt, "Composite Electrode Boosts the Activity of Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-δ} Perovskite and Carbon toward Oxygen Reduction in Alkaline Media," *ACS Catalysis*, 4(2014)1061–1070.
- [175] S. Zhao, Y. Yang, Z. Tang, "Insight into Structural Evolution, Active Sites, and Stability of Heterogeneous Electrocatalysts," *Angewandte Chemie International Edition*, 61(2022) 202110186.
- [176] Z. Liu, Y. Wang, R. Chen, C. Chen, H. Yang, J. Ma, Y. Li, S. Wang, "Origin of the ultra-high activity for oxygen evolution," *Journal of Power Sources*, 403(2018)90–96.
- [177] L.-A. Stern, L. Feng, F. Song, X. Hu, "Ni₂P as a Janus catalyst for water splitting: the oxygen evolution activity of Ni₂P nanoparticles," *Energy Environmental Science*, 8(2015)2347–2351.
- [178] B. Singh, A. Indra, O. Prakash, P. Maiti, "Electrochemical Transformation of Metal Organic Framework into Ultrathin Metal Hydroxide-(oxy)hydroxide Nanosheets for Alkaline Water Oxidation," *ACS Applied Nano Materials*, 3(2020)6693–6701.
- [179] J. Zhou, Y. Wang, X. Su, S. Gu, R. Liu, Y. Huang, S. Yan, J. Li, S. Zhang, "Electrochemically accessing ultrathin Co(oxy)-hydroxide nanosheets and operando identifying their active phase for the oxygen evolution reaction," *Energy Environmental Science*, 12(2019)739–746.
- [180] X. Su, Y. Wang, J. Zhou, S. Gu, J. Li, S. Zhang, "Operando Spectroscopic

- Identification of Active Sites in NiFe Prussian Blue Analogues as Electrocatalysts: Activation of Oxygen Atoms for Oxygen Evolution Reaction,” *Journal of American Chemical Society*, 140(2018)11286–11292.
- [181] J. Tian, F. Jiang, D. Yuan, L. Zhang, Q. Chen, M. Hong, “Electric-Field Assisted In Situ Hydrolysis of Bulk Metal–Organic Frameworks (MOFs) into Ultrathin Metal Oxyhydroxide Nanosheets for Efficient Oxygen Evolution,” *Angewandte Chemie International Edition*, 59(2020)13101–13108.
- [182] M. Zhang, W. Xu, T. Li, H. Zhu, Y. Zheng, “In Situ Growth of Tetrametallic FeCoMnNi-MOF-74 on Nickel Foam as Efficient Bifunctional Electrocatalysts for the Evolution Reaction of Oxygen and Hydrogen,” *Inorganic Chemistry*, 59(2020)15467–15477.
- [183] J. Ding, T. Fan, K. Shen, Y. Li, “Electrochemical synthesis of amorphous metal hydroxide microarrays with rich defects from MOFs for efficient electrocatalytic water oxidation,” *Applied Catalysis B: Environmental*, 292(2021)120174.
- [184] Z. Ye, Y. Jiang, L. Li, F. Wu, R. Chen, “Rational Design of MOF-Based Materials for Next-Generation Rechargeable Batteries,” *Nano-Micro Letters*, 203(2021)321.
- [185] C.S. Diercks, M.J. Kalmutzki, N.J. Diercks, O.M. Yaghi, “Conceptual Advances from Werner Complexes to Metal-Organic Frameworks,” *ACS Central Science*, 4(2018)1457–1464.
- [186] T. Iwamoto, T. Nakano, M. Morita, T. Miyoshi, T. Miyamoto, Y. Sasaki, “The Hofman-type clathrate: $M(NH_3)_2M'(CN)_4 \cdot 2G$,” *Inorganica Chimica Acta*, 2(1968)313–316.
- [187] K.A. Hofmann, F. Küspert, “Verbindungen von Kohlenwasserstoffen mit Metallsalzen,” *Zeitschrift Für Anorg. Chemie*, 15(1897)204–207.
- [188] H. Li, M. Eddaoudi, M. O’Keeffe, O.M. Yaghi, “Design and synthesis of an exceptionally stable and highly porous metal-organic framework,” *Nature*, 402(1999)276–279.
- [189] S.M. Cohen, “Postsynthetic Methods for the Functionalization of Metal–Organic Frameworks,” *Chemical Reviews*, 112(2012)970–1000.
- [190] D.N. Dybtsev, H. Chun, K. Kim, “Rigid and Flexible: A Highly Porous Metal–Organic Framework with Unusual Guest-Dependent Dynamic Behavior,” *Angewandte Chemie International Edition*, 43(2004)5033–5036.
- [191] K. Seki, W. Mori, “Syntheses and Characterization of Microporous Coordination Polymers with Open Frameworks,” *Journal of Physical Chemistry B*, 106(2002)1380–1385.
- [192] Z. Wan, D. Yang, J. Chen, J. Tian, T.T. Isimjan, X. Yang, “Oxygen-Evolution Catalysts Based on Iron-Mediated Nickel Metal-Organic Frameworks,” *ACS Applied Nano Materials*, 2(2019)6334–6342.
- [193] D.F. Mullica, D.B. Tippin, E.L. Sappenfield, “Synthesis, spectroscopic studies and x-ray crystal structure analysis of cobalt nitroprusside, $Co[Fe(CN)_5NO] \cdot 5H_2O$,” *Journal of Coordination Chemistry*, 24(1991)83–91.
- [194] J. Nai, J. Zhang, X.W. (David) Lou, “Construction of Single-Crystalline Prussian Blue Analog Hollow Nanostructures with Tailorable Topologies,” *Chem*, 4(2018)1967–1982.
- [195] H. Bin Wu, X.W. (David) Lou, “Metal-organic frameworks and their derived materials for electrochemical energy storage and conversion: Promises and challenges,” *Science Advance*, 3(2017)9252.
- [196] R. Zhao, Z. Liang, R. Zou, Q. Xu, “Metal-Organic Frameworks for Batteries,” *Joule*, 2(2018)2235–2259.
- [197] L. Wang, Y. Han, X. Feng, J. Zhou, P. Qi, B. Wang, “Metal–organic frameworks

-
- for energy storage: Batteries and supercapacitors,” *Coordination Chemistry Reviews*, 307(2016)361–381.
- [198] Q. Shao, J. Yang, X. Huang, “The Design of Water Oxidation Electrocatalysts from Nanoscale Metal–Organic Frameworks,” *Chemistry –A European Journal*, 24(2018)15143–15155.
- [199] K.K. Gangu, S. Maddila, S.B. Mukkamala, S.B. Jonnalagadda, “A review on contemporary Metal–Organic Framework materials,” *Inorganica Chimica Acta*, 446(2016)61–74.
- [200] L. Oar-Arteta, T. Wezendonk, X. Sun, F. Kapteijn, J. Gascon, “Metal organic frameworks as precursors for the manufacture of advanced catalytic materials,” *Materials Chemistry Frontiers*, 1(2017)1709–1745.
- [201] M. Dincă, J.R. Long, “Strong H₂ Binding and Selective Gas Adsorption within the Microporous Coordination Solid Mg₃(O₂C–C₁₀H₆–CO₂)₃,” *Journal of American Chemical Society*, 127(2005)9376–9377.
- [202] N. Klein, I. Senkowska, K. Gedrich, U. Stoeck, A. Henschel, U. Mueller, S. Kaskel, “A Mesoporous Metal–Organic Framework,” *Angewandte Chemie International Edition*, 48(2009)9954–9957.
- [203] S.S.-Y. Chui, S.M.-F. Lo, J.P.H. Charmant, A.G. Orpen, I.D. Williams, “A Chemically Functionalizable Nanoporous Material [Cu₃(TMA)₂(H₂O)₃]_n,” *Science*, 283(1999)1148–1150.
- [204] H. Furukawa, N. Ko, Y.B. Go, N. Aratani, S.B. Choi, E. Choi, A.Ö. Yazaydin, R.Q. Snurr, M. O’Keeffe, J. Kim, O.M. Yaghi, “Ultra-high Porosity in Metal–Organic Frameworks,” *Science*, 329(2010)424–428.
- [205] R.A. Fischer, C. Wöll, “Functionalized Coordination Space in Metal–Organic Frameworks,” *Angewandte Chemie International Edition*, 47(2008)8164–8168.
- [206] H. Deng, C.J. Doonan, H. Furukawa, R.B. Ferreira, J. Towne, C.B. Knobler, B. Wang, O.M. Yaghi, “Multiple Functional Groups of Varying Ratios in Metal–Organic Frameworks,” *Science*, 327(2010)846–850.
- [207] K.K. Tanabe, Z. Wang, S.M. Cohen, “Systematic Functionalization of a Metal–Organic Framework via a Postsynthetic Modification Approach,” *Journal of American Chemical Society*, 130(2008)8508–8517.
- [208] Z. Wang, S.M. Cohen, “Post synthetic Covalent Modification of a Neutral Metal–Organic Framework,” *Journal of American Chemical Society*, 129(2007)12368–12369.
- [209] U. Mueller, M. Schubert, F. Teich, H. Puetter, K. Schierle-Arndt, J. Pastré, “Metal–organic frameworks—prospective industrial applications,” *Journal of Materials Chemistry*, 16(2006)626–636.
- [210] H.-L. Jiang, Q. Xu, “Porous metal–organic frameworks as platforms for functional applications,” *Chemical Communications*, 47(2011)3351–3370.
- [211] C. Sanchez, P. Belleville, M. Popall, L. Nicole, “Applications of advanced hybrid organic–inorganic nanomaterials: from laboratory to market,” *Chemical Society Reviews*, 40(2011)696–753.
- [212] J.-R. Li, R.J. Kuppler, H.-C. Zhou, “Selective gas adsorption and separation in metal–organic frameworks,” *Chemical Society Reviews*, 38(2009)1477–1504.
- [213] G. Férey, C. Serre, T. Devic, G. Maurin, H. Jobic, P.L. Llewellyn, G. De Weireld, A. Vimont, M. Daturi, J.-S. Chang, “Why hybrid porous solids capture greenhouse gases?,” *Chemical Society Reviews*, 40(2011)550–562.
- [214] B. Kong, C. Selomulya, G. Zheng, D. Zhao, “New faces of porous Prussian blue: interfacial assembly of integrated hetero-structures for sensing applications,” *Chemical Society Reviews*, 44(2015)7997–8018.
-

-
-
- [215] J. Nai, X.W. (David) Lou, "Hollow Structures Based on Prussian Blue and Its Analogs for Electrochemical Energy Storage and Conversion," *Advanced Materials*, 31(2019)1706825.
- [216] A. Kraft, "On the Discovery and History of Prussian Blue," *Bulletin for the History of Chemistry*, 32(2008)61–67.
- [217] M.B. Zakaria, T. Chikyow, "Recent advances in Prussian blue and Prussian blue analogues: synthesis and thermal treatments," *Coordination Chemistry Reviews*, 352(2017)328–345.
- [218] B. Wang, Y. Han, X. Wang, N. Bahlawane, H. Pan, M. Yan, Y. Jiang, "Prussian Blue Analogs for Rechargeable Batteries," *iScience*, 3(2018)110–133.
- [219] K. Hurlbutt, S. Wheeler, I. Capone, M. Pasta, "Prussian Blue Analogs as Battery Materials," *Joule*, 2(2018)1950–1960.
- [220] L. Han, P. Tang, Á. Reyes-Carmona, B. Rodríguez-García, M. Torrén, J.R. Morante, J. Arbiol, J.R. Galan-Mascaros, "Enhanced Activity and Acid pH Stability of Prussian Blue-type Oxygen Evolution Electrocatalysts Processed by Chemical Etching," *Journal of American Chemical Society*, 138(2016)16037–16045.
- [221] J.B. Tan, G.R. Li, "Recent progress on metal-organic frameworks and their derived materials for electrocatalytic water splitting," *Journal of Materials Chemistry A*, 8(2020)14326–14355.
- [222] R. Patel, J.T. Park, M. Patel, J.K. Dash, E.B. Gowd, R. Karpoornath, A. Mishra, J. Kwak, J.H. Kim, "Transition-metal-based layered double hydroxides tailored for energy conversion and storage," *Journal of Materials Chemistry A*, 6(2018)12–29.
- [223] B.R. Wygant, K. Kawashima, C.B. Mullins "Catalyst or Precatalyst? The Effect of Oxidation on Transition Metal Carbide, Pnictide, and Chalcogenide Oxygen Evolution Catalysts," *ACS Energy Letters*, 3(2018)2956–2966.
- [224] F. Sun, G. Wang, Y. Ding, C. Wang, B. Yuan, Y. Lin, "NiFe-Based Metal–Organic Framework Nanosheets Directly Supported on Nickel Foam Acting as Robust Electrodes for Electrochemical Oxygen Evolution Reaction," *Advanced Energy Materials*, 8(2018)1800584.
- [225] J. Duan, S. Chen, C. Zhao, "Ultrathin metal-organic framework array for efficient electrocatalytic water splitting," *Nature Communications*, 8(2017)15341.
- [226] Q. Qian, Y. Li, Y. Liu, L. Yu, G. Zhang, "Ambient Fast Synthesis and Active Sites Deciphering of Hierarchical Foam-Like Trimetal–Organic Framework Nanostructures as a Platform for Highly Efficient Oxygen Evolution Electrocatalysis," *Advanced Materials*, 31(2019)1901139.
- [227] S. Zhao, C. Tan, C.T. He, P. An, F. Xie, S. Jiang, Y. Zhu, K.H. Wu, B. Zhang, H. Li, J. Zhang, Y. Chen, S. Liu, J. Dong, Z. Tang, "Structural transformation of highly active metal–organic framework electrocatalysts during the oxygen evolution reaction," *Nature Energy*, 5(2020)881–890.
- [228] S. Pintado, S. Goberna-Ferrón, E.C. Escudero-Adán, J.R. Galán-Mascarós, "Fast and Persistent Electrocatalytic Water Oxidation by Co–Fe Prussian Blue Coordination Polymers," *Journal of American Chemical Society*, 135(2013)13270–13273.
- [229] S. Jo, S. Noh, K.R. Wee, J.H. Shim, "Structural Features of Porous CoFe Nanocubes and Their Performance for Oxygen-involving Energy Electrocatalysis," *ChemElectroChem*, 7(2020)3725–3732.
- [230] S.J. Gerber, E. Erasmus, "Electronic effects of metal hexacyanoferrates: An XPS and FTIR study," *Materials Chemistry Physics*, 203(2018)73–81.
- [231] M. Luo, Y. Dou, H. Kang, Y. Ma, X. Ding, B. Liang, B. Ma, L. Li, "A novel

- interlocked Prussian blue/reduced graphene oxide nanocomposites as high-performance supercapacitor electrodes,” *Journal of Solid State Electrochemistry*, 19(2015)1621–1631.
- [232] F.D. Speck, K.E. Dettelbach, R.S. Sherbo, D.A. Salvatore, A. Huang, C.P. Berlinguette, “On the Electrolytic Stability of Iron-Nickel Oxides,” *Chem*, 2(2017)590–597.
- [233] Z. Lei, X. Jin, J. Li, Y. Liu, J. Liu, S. Jiao, R. Cao, “Tuning electrochemical transformation process of zeolitic imidazolate framework for efficient water oxidation activity,” *Journal of Energy Chemistry*, 65(2022)505–513.
- [234] J. Rodríguez-Hernández, E. Reguera, E. Lima, J. Balmaseda, R. Martínez-García, H. Yee-Madeira, “An atypical coordination in hexacyanometallates: Structure and properties of hexagonal zinc phases,” *Journal of Physics and Chemistry of Solids*, 68(2007)1630–1642.
- [235] G.W. Beall, D.F. Mullica, W.O. Milligan, J. Korp, I. Bernal, “The crystal structure of $\text{LaKFe(CN)}_6 \cdot 4\text{H}_2\text{O}$,” *Acta Crystallographica Section B*, 34(1978)1446–1449.
- [236] D.F. Mullica, W.O. Milligan, J.D. Oliver, “Refined structure of $\text{CeKFe(CN)}_6 \cdot 4\text{H}_2\text{O}$,” *Inorganic and Nuclear Chemistry Letters*, 15(1979)1–5.
- [237] Y. Yan, J. Huang, X. Wang, T. Gao, Y. Zhang, T. Yao, B. Song, “Ruthenium Incorporated Cobalt Phosphide Nanocubes Derived From a Prussian Blue Analog for Enhanced Hydrogen Evolution,” *Frontiers Chemistry*, 6(2018)521.
- [238] X. Roy, L.K. Thompson, N. Coombs, M.J. MacLachlan, “Mesostructured Prussian Blue Analogues,” *Angewandte Chemie International Edition*, 47(2008)511–514.
- [239] S.M. Contakes, K.K. Klausmeyer, T.B. Rauchfuss, “Coordination Solids Derived from $\text{Cp}^*\text{M(CN)}_3$ - (M = Rh, Ir),” *Inorganic Chemistry*, 39(2000)2069–2075.
- [240] B. Singh, P. Mannu, Y.-C. Huang, R. Prakash, S. Shen, C.-L. Dong, A. Indra, “Deciphering Ligand Controlled Structural Evolution of Prussian Blue Analogues and Their Electrochemical Activation during Alkaline Water Oxidation,” *Angewandte Chemie International Edition*, 61(2022)e202211585.
- [241] L. Reguera, Y. Avila, E. Reguera, “Transition metal nitroprussides: Crystal and electronic structure, and related properties,” *Coordination Chemistry Reviews*, 434(2021)213764.
- [242] A. Cano, L. Lartundo-Rojas, A. Shchukarev, E. Reguera, “Contribution to the coordination chemistry of transition metal nitroprussides: a cryo-XPS study,” *New Journal of Chemistry*, 43(2019)4835–4848.
- [243] V. Cuartero, S. Lafuerza, M. Rovezzi, J. García, J. Blasco, G. Subías, E. Jiménez, “X-ray absorption and emission spectroscopy study of Mn and Co valence and spin states in $\text{TbMn}_{1-x}\text{Co}_x\text{O}_3$,” *Physical Review B*, 94(2016)155117.
- [244] M. Benfatto, C.R. Natoli, A. Bianconi, J. Garcia, A. Marcelli, M. Fanfoni, I. Davoli, “Multiple-scattering regime and higher-order correlations in X-ray-absorption spectra of liquid solutions,” *Physical Review B*, 34(1986)5774–5781.
- [245] C. Maurizio, N. El Habra, G. Rossetto, M. Merlini, E. Cattaruzza, L. Pandolfo, M. Casarin, “XAS and GIXRD Study of Co Sites in CoAl_2O_4 Layers Grown by MOCVD,” *Chemistry of Materials*, 22(2010)1933–1942.
- [246] Y. Joly, “X-ray absorption near-edge structure calculations beyond the muffin-tin approximation,” *Physical Review B*, 63(2001)125120.
- [247] J. Chen, H. Li, S. Chen, J. Fei, C. Liu, Z. Yu, K. Shin, Z. Liu, L. Song, G. Henkelman, L. Wei, Y. Chen, “Co-Fe-Cr (oxy)Hydroxides as Efficient Oxygen Evolution Reaction Catalysts,” *Advanced Energy Materials*, 11(2021)2003412.
- [248] S. Song, H. Bao, X. Lin, X.-L. Du, J. Zhou, L. Zhang, N. Chen, J. Hu, J.-Q. Wang, “Molten salt-assisted synthesis of bulk CoOOH as a water oxidation catalyst,”

-
- Journal of Energy Chemistry*, 42(2020)5–10.
- [249] E. Piskorska-Hommel, A. Ciupa-Litwa, “Local structure study of the Fe ions in mixed-valence iron(II)-iron(III) metal formate frameworks,” *Polyhedron*, 223(2022)115963.
- [250] G.A. Waychunas, G.E. Brown, M.J. APTED, “X-ray K-edge absorption spectra of Fe minerals and model compounds: II. EXAFS,” *Physics and Chemistry of Minerals*, 13(1986)31–47.
- [251] T. Gholam, L.R. Zheng, J.O. Wang, H.J. Qian, R. Wu, H.-Q. Wang, “Synchrotron X-ray Absorption Spectroscopy Study of Local Structure in Al-Doped BiFeO₃ Powders,” *Nanoscale Research Letters*, 14(2019)137.
- [252] D. Wang, J. Zhou, Y. Hu, J. Yang, N. Han, Y. Li, T.-K. Sham, “In Situ X-ray Absorption Near-Edge Structure Study of Advanced NiFe(OH)_x Electrocatalyst on Carbon Paper for Water Oxidation,” *Journal of Physical Chemistry C*, 119(2015)19573–19583.
- [253] J. Zhu, Z. Zeng, W.-X. Li, “K-Edge XANES Investigation of Fe-Based Oxides by Density Functional Theory Calculations,” *Journal of Physical Chemistry C*, 125(2021)26229–26239.
- [254] D. Zhou, S. Permien, J. Rana, M. Krengel, F. Sun, G. Schumacher, W. Bensch, J. Banhart, “Investigation of electronic and local structural changes during lithium uptake and release of nano-crystalline NiFe₂O₄ by X-ray absorption spectroscopy,” *Journal of Power Sources*, 342(2017)56–63.
- [255] N. Li, R.G. Hadt, D. Hayes, L.X. Chen, D.G. Nocera, “Detection of high-valent iron species in alloyed oxidic cobaltates for catalysing the oxygen evolution reaction,” *Nature Communications*, 12(2021)6–11.
- [256] A. Bergmann, T.E. Jones, E. Martinez Moreno, D. Teschner, P. Chernev, M. Gliech, T. Reier, H. Dau, P. Strasser, “Unified structural motifs of the catalytically active state of Co(oxyhydr)oxides during the electrochemical oxygen evolution reaction,” *Nature Catalysis*, 1(2018)711–719.
- [257] S. Wahl, S.M. El-Refaei, A.G. Buzanich, P. Amsalem, K.-S. Lee, N. Koch, M.-L. Doublet, N. Pinna, “Zn_{0.35}Co_{0.65}O—A Stable and Highly Active Oxygen Evolution Catalyst Formed by Zinc Leaching and Tetrahedral Coordinated Cobalt in Wurtzite Structure,” *Advanced Energy Materials*, 9(2019)1900328.
- [258] Z. Li, H. Duan, M. Shao, J. Li, D. O’Hare, M. Wei, Z.L. Wang, “Ordered-Vacancy-Induced Cation Intercalation into Layered Double Hydroxides: A General Approach for High-Performance Supercapacitors,” *Chem*, 4(2018)2168–2179.
- [259] Y. Wang, Y. Zhang, Z. Liu, C. Xie, S. Feng, D. Liu, M. Shao, S. Wang, “Layered Double Hydroxide Nanosheets with Multiple Vacancies Obtained by Dry Exfoliation as Highly Efficient Oxygen Evolution Electrocatalysts,” *Angewandte Chemie International Edition*, 56(2015)5867–5871.
- [260] L.J. Enman, M.B. Stevens, M.H. Dahan, M.R. Nellist, M.C. Toroker, S.W. Boettcher, “Operando X-Ray Absorption Spectroscopy Shows Iron Oxidation Is Concurrent with Oxygen Evolution in Cobalt–Iron (Oxy)hydroxide Electrocatalysts,” *Angewandte Chemie International Edition*, 57(2018)12840–12844.
- [261] D. Friebe, M.W. Louie, M. Bajdich, K.E. Sanwald, Y. Cai, A.M. Wise, M.J. Cheng, D. Sokaras, T.C. Weng, R. Alonso-Mori, R.C. Davis, J.R. Bargar, J.K. Nørskov, A. Nilsson, A.T. Bell, “Identification of highly active Fe sites in (Ni,Fe)OOH for electrocatalytic water splitting,” *Journal of American Chemical Society*, 137(2015)1305–1313.
- [262] X. Bai, Z. Duan, B. Nan, L. Wang, T. Tang, J. Guan, “Unveiling the active sites of

-
- ultrathin Co-Fe layered double hydroxides for the oxygen evolution reaction,” *Chinese Journal of Catalysis*, 43(2022)2240–2248.
- [263] G. vander Laan, I.W. Kirkman, “The 2p absorption spectra of 3d transition metal compounds in tetrahedral and octahedral symmetry,” *Journal of Physics: Condensed Matter*, 4(1992)4189–4204.
- [264] D. Gajdek, P.A.T. Olsson, S. Blomberg, J. Gustafson, P.-A. Carlsson, D. Haase, E. Lundgren, L.R. Merte, “Structural Changes in Monolayer Cobalt Oxides under Ambient Pressure CO and O₂ Studied by In Situ Grazing-Incidence X-ray Absorption Fine Structure Spectroscopy,” *Journal of Physical Chemistry C*, 126(2022)3411–3418.
- [265] X. Zheng, H. Quan, X. Li, H. He, Q. Ye, X. Xu, F. Wang, “In situ fabrication of Ni–Co (oxy)hydroxide nanowire-supported nanoflake arrays and their application in supercapacitors,” *Nanoscale*, 8(2016)17055–17063.
- [266] H. Guo, T. Li, W. Chen, L. Liu, X. Yang, Y. Wang, Y. Guo, “General design of hollow porous CoFe₂O₄ nanocubes from metal–organic frameworks with extraordinary lithium storage,” *Nanoscale*, 6(2014)15168–15174.
- [267] Z. Chen, B. Fei, M. Hou, X. Yan, M. Chen, H. Qing, R. Wu, “Ultrathin Prussian blue analogue nanosheet arrays with open bimetal centers for efficient overall water splitting,” *Nano Energy*, 68(2020)104371.
- [268] S. Lei, Q.H. Li, Y. Kang, Z.G. Gu, J. Zhang, “Epitaxial growth of oriented prussian blue analogue derived well-aligned CoFe₂O₄ thin film for efficient oxygen evolution reaction,” *Applied Catalysis B: Environmental*, 245(2019)1–9.
- [269] Y. Feng, H.S. Han, K.M. Kim, S. Dutta, T. Song, “Self-templated Prussian blue analogue for efficient and robust electrochemical water oxidation,” *Journal of Catalysis*, 369(2019)168–174.
- [270] H.J. Niu, Y.P. Chen, R.M. Sun, A.J. Wang, L.P. Mei, L. Zhang, J.J. Feng, “Prussian blue analogue-derived CoFe nanocrystals wrapped in nitrogen-doped carbon nanocubes for overall water splitting and Zn-air battery,” *Journal of Power Sources*, 480(2020)229107.
- [271] H. Zou, X. Liu, K. Wang, Y. Duan, C. Wang, B. Zhang, K. Zhou, D. Yu, L.-Y. Gan, X. Zhou, “Constructing highly active Co sites in Prussian blue analogues for boosting electrocatalytic water oxidation,” *Chemical Communications*, 57(2021)8011–8014.
- [272] N.L.W. Septiani, Y.V. Kaneti, Y. Guo, B. Yulianto, X. Jiang, Y. Ide, N. Nugraha, H.K. Dipojono, A. Yu, Y. Sugahara, D. Golberg, Y. Yamauchi, “Holey Assembly of Two-Dimensional Iron-Doped Nickel-Cobalt Layered Double Hydroxide Nanosheets for Energy Conversion Application,” *ChemSusChem*, 13(2020)1645–1655.
- [273] C. Ray, S.C. Lee, B. Jin, A. Kundu, J.H. Park, S.C. Jun, “Stacked Porous Iron-Doped Nickel Cobalt Phosphide Nanoparticle: An Efficient and Stable Water Splitting Electrocatalyst,” *ACS Sustainable Chemistry & Engineering*, 6(2018)6146–6156.
- [274] P. Wang, Z. Pu, Y. Li, L. Wu, Z. Tu, M. Jiang, Z. Kou, I.S. Amiinu, S. Mu, “Iron-Doped Nickel Phosphide Nanosheet Arrays: An Efficient Bifunctional Electrocatalyst for Water Splitting,” *ACS Applied Materials & Interfaces*, 9(2017)26001–26007.
- [275] H. Ding, H. Liu, W. Chu, C. Wu, Y. Xie, “Structural Transformation of Heterogeneous Materials for Electrocatalytic Oxygen Evolution Reaction,” *Chemical Reviews*, 121(2021)13174–13212.
- [276] Y. Holade, N. Tuleushova, S. Tingry, K. Servat, T.W. Napporn, H. Guesmi, D.
-

-
- Cornua, K.B. Kokoh, "Recent advances in the electrooxidation of biomass-based organic molecules for energy, chemicals and hydrogen production," *Catalysis Science and Technology*, 10(2020)3071-3112.
- [277] X. Liu, Y. Han, Y. Guo, X. Zhao, D. Pan, K. Li, Z. Wen, "Electrochemical Hydrogen Generation by Oxygen Evolution Reaction-Alternative Anodic Oxidation Reactions," *Advanced Energy and Sustainability Research*, 3(2022)2200005.
- [278] R. Li, K. Xiang, Z. Peng, Y. Zou, S. Wang, "Recent Advances on Electrolysis for Simultaneous Generation of Valuable Chemicals at both Anode and Cathode," *Advanced Energy Materials*, 11(2021)2102292.
- [279] Y. Li, X. Wei, L. Chen, J. Shi, "Electrocatalytic Hydrogen Production Trilogy," *Angewandte Chemie International Edition*, 60(2021)19550-19571.
- [280] F. Arshad, T. ul Haq, I. Hussain, F. Sher, "Recent Advances in Electrocatalysts toward Alcohol-Assisted, Energy-Saving Hydrogen Production," *ACS Applied Energy Materials*, 4(2021)8685-8701.
- [281] J. Zheng, X. Chen, X. Zhong, S. Li, T. Liu, G. Zhuang, X. Li, S. Deng, D. Mei, J.-G. Wang, "Hierarchical Porous NC@CuCo Nitride Nanosheet Networks: Highly Efficient Bifunctional Electrocatalyst for Overall Water Splitting and Selective Electrooxidation of Benzyl Alcohol," *Advanced Functional Materials*, 27(2017)1704169.
- [282] Z. Yin, Y. Zheng, H. Wang, J. Li, Q. Zhu, Y. Wang, N. Ma, G. Hu, B. He, A. Knop-Gericke, R. Schlögl, D. Ma, "Engineering Interface with One-Dimensional Co₃O₄ Nanostructure in Catalytic Membrane Electrode: Toward an Advanced Electrocatalyst for Alcohol Oxidation," *ACS Nano*, 11(2017)12365-12377.
- [283] H. Huang, C. Yu, X. Han, H. Huang, Q. Wei, W. Guo, Z. Wang, J. Qiu, "Ni, Co hydroxide triggers electrocatalytic production of high-purity benzoic acid over 400 mA cm⁻²," *Energy Environmental Science*, 13(2020)4990-4999.
- [284] Z. Li, Y. Yan, S.-M. Xu, H. Zhou, M. Xu, L. Ma, M. Shao, X. Kong, B. Wang, L. Zheng, H. Duan, "Alcohols electrooxidation coupled with H₂ production at high current densities promoted by a cooperative catalyst," *Nature Communications*, 13(2022)147.
- [285] J. Lejeune, J.-B. Brubach, P. Roy, A. Bleuzen, "Application of the infrared spectroscopy to the structural study of Prussian blue analogues," *Comptes Rendus Chimie*, 17(2014) 534-540.
- [286] H. Niwa, T. Moriya, T. Shibata, Y. Fukuzumi, Y. Moritomo, "In situ IR spectroscopy during oxidation process of cobalt Prussian blue analogues," *Scientific Reports*, 11(2021)4119.
- [287] Y. Feng, X. Wang, P. Dong, J. Li, L. Feng, J. Huang, L. Cao, L. Feng, K. Kajiyoshi, C. Wang, "Boosting the activity of Prussian-blue analogue as efficient electrocatalyst for water and urea oxidation," *Scientific Reports*, 9(2019)15965.
- [288] X. Ma, C. Chang, Y. Zhang, P. Niu, X. Liu, S. Wang, L. Li, "Synthesis of Co-based Prussian Blue Analogues/Dual-Doped Hollow Carbon Microsphere Hybrids as High-Performance Bifunctional Electrocatalysts for Oxygen Evolution and Overall Water Splitting," *ACS Sustainable Chemistry & Engineering*, 8(2020)8318-8326.
- [289] E.P. Alsaç, E. Ülker, S.V.K. Nune, Y. Dede, F. Karadas, "Tuning the Electronic Properties of Prussian Blue Analogues for Efficient Water Oxidation Electrocatalysis: Experimental and Computational Studies," *Chemistry – A European Journal*, 24(2018)4856-4863.
-

-
-
- [290] L. Han, X.-Y. Yu, X.W. Lou, "Formation of Prussian-Blue-Analog Nanocages via a Direct Etching Method and their Conversion into Ni-Co-Mixed Oxide for Enhanced Oxygen Evolution," *Advanced Materials*, 28(2016)4601–4605.
- [291] Y. Feng, X.-Y. Yu, U. Paik, "Formation of Co₃O₄ microframes from MOFs with enhanced electrochemical performance for lithium storage and water oxidation," *Chemical Communications*, 52(2016)6269–6272.
- [292] X.-Y. Yu, Y. Feng, B. Guan, X.W. Lou, U. Paik, "Carbon coated porous nickel phosphides nanoplates for highly efficient oxygen evolution reaction," *Energy Environmental Science*, 9(2016)1246–1250.
- [293] W. Ahn, M.G. Park, D.U. Lee, M.H. Seo, G. Jiang, Z.P. Cano, F.M. Hassan, Z. Chen, "Hollow Multivoid Nanocuboids Derived from Ternary Ni-Co-Fe Prussian Blue Analog for Dual-Electrocatalysis of Oxygen and Hydrogen Evolution Reactions," *Advanced Functional Materials*, 28(2018)1802129.
- [294] H.-H. Zou, C.-Z. Yuan, H.-Y. Zou, T.-Y. Cheang, S.-J. Zhao, U.Y. Qazi, S.-L. Zhong, L. Wang, A.-W. Xu, "Bimetallic phosphide hollow nanocubes derived from a prussian-blue-analog used as high-performance catalysts for the oxygen evolution reaction," *Catalysis Science and Technology*, 7(2017)1549–1555.
- [295] C. Xuan, J. Wang, W. Xia, Z. Peng, Z. Wu, W. Lei, K. Xia, H. L. Xin, D. Wang, "Porous Structured Ni-Fe-P Nanocubes Derived from a Prussian Blue Analogue as an Electrocatalyst for Efficient Overall Water Splitting," *ACS Applied Materials & Interfaces*, 9(2017)26134–26142.
- [296] X. Xu, H. Liang, F. Ming, Z. Qi, Y. Xie, Z. Wang, "Prussian Blue Analogues Derived Penroseite (Ni,Co)Se₂ Nanocages Anchored on 3D Graphene Aerogel for Efficient Water Splitting," *ACS Catalysis*, 7(2017)6394–6399.
- [297] C.-H. Chuang, L.-Y. Hsiao, M.-H. Yeh, Y.-C. Wang, S.-C. Chang, L.-D. Tsai, K.-C. Ho, "Prussian Blue Analogue-Derived Metal Oxides as Electrocatalysts for Oxygen Evolution Reaction: Tailoring the Molar Ratio of Cobalt to Iron," *ACS Applied Energy Materials*, 3(2020)11752–11762.
- [298] Y.X. Yang, B.L. Li, Q. Zhang, W.H. Guo, X.H. Wang, L.J. Li, H.Q. Luo, N.B. Li, "Prussian Blue Analogues-Derived CoFe-B Nanocubes with Increased Specific Surface Area and Modulated Electronic Structure as Enhanced Oxygen Evolution Electrocatalysts," *Energy Technology*, 9(2021)2000178.
- [299] D. Li, C. Zhou, Y. Xing, X. Shi, W. Ma, L. Li, D. Jiang, W. Shi, "Oxygen-doped hollow, porous NiCoP nanocages derived from Ni-Co prussian blue analogs for oxygen evolution," *Chemical Communications*, 57(2021)8158–8161.
- [300] X. Liu, J. Dong, B. You, Y. Sun, "Competent overall water-splitting electrocatalysts derived from ZIF-67 grown on carbon cloth," *RSC Advances*, 6(2016)73336–73342.
- [301] J. Meng, J. Fu, X. Yang, M. Wei, S. Liang, H.-Y. Zang, H. Tan, Y. Wang, Y. Li, "Efficient MMoO₄ (M = Co, Ni) carbon cloth electrodes for water oxidation," *Inorganic Chemistry Frontiers*, 4(2017)1791–1797.
- [302] A. Kargar, S. Yavuz, T.K. Kim, C.-H. Liu, C. Kuru, C.S. Rustomji, S. Jin, P.R. Bandaru, "Solution-Processed CoFe₂O₄ Nanoparticles on 3D Carbon Fiber Papers for Durable Oxygen Evolution Reaction," *ACS Applied Materials & Interfaces*, 7(2015)17851–17856.
- [303] J. Liu, S.B. Hartono, Y.G. Jin, Z. Li, G.Q. Lu, S.Z. Qiao, "A facile vesicle template route to multi-shelled mesoporous silica hollow nanospheres," *Journal of Materials Chemistry*, 20(2010)4595–4601.
- [304] C. Xia, Q. Jiang, C. Zhao, M.N. Hedhili, H.N. Alshareef, "Selenide-Based Electrocatalysts and Scaffolds for Water Oxidation Applications," *Advanced*

-
- Materials*, 28(2016)77–85.
- [305] L. Feng, A. Li, Y. Li, J. Liu, L. Wang, L. Huang, Y. Wang, X. Ge, “A Highly Active CoFe Layered Double Hydroxide for Water Splitting,” *ChemPlusChem*, 82(2017)483–488.
- [306] X. Zou, A. Goswami, T. Asefa, “Efficient Noble Metal-Free (Electro)Catalysis of Water and Alcohol Oxidations by Zinc–Cobalt Layered Double Hydroxide,” *Journal of American Chemical Society*, 135(2013)17242–17245.
- [307] X. Yu, M. Zhang, W. Yuan, G. Shi, “A high-performance three-dimensional Ni–Fe layered double hydroxide/graphene electrode for water oxidation,” *Journal of Materials Chemistry A*, 3(2015)6921–6928.
- [308] F. Song, X. Hu, “Ultrathin Cobalt–Manganese Layered Double Hydroxide Is an Efficient Oxygen Evolution Catalyst,” *Journal of American Chemical Society*, 136(2014)16481–16484.
- [309] Y. Li, C. Zhao, “Enhancing Water Oxidation Catalysis on a Synergistic Phosphorylated NiFe Hydroxide by Adjusting Catalyst Wettability,” *ACS Catalysis*, 7(2017)2535–2541.
- [310] C. Dong, X. Yuan, X. Wang, X. Liu, W. Dong, R. Wang, Y. Duan, F. Huang, “Rational design of cobalt–chromium layered double hydroxide as a highly efficient electrocatalyst for water oxidation,” *Journal of Materials Chemistry A*, 4(2016)11292–11298.
- [311] H. Liang, F. Meng, M. Cabán-Acevedo, L. Li, A. Forticaux, L. Xiu, Z. Wang, S. Jin, “Hydrothermal Continuous Flow Synthesis and Exfoliation of NiCo Layered Double Hydroxide Nanosheets for Enhanced Oxygen Evolution Catalysis,” *Nano Letters*, 15(2015)1421–1427.
- [312] R. Liu, Y. Wang, D. Liu, Y. Zou, S. Wang, “Water-Plasma-Enabled Exfoliation of Ultrathin Layered Double Hydroxide Nanosheets with Multivacancies for Water Oxidation,” *Advanced Materials*, 29(2017)1701546.
- [313] N. Han, F. Zhao, Y. Li, Ultrathin nickel–iron layered double hydroxide nanosheets intercalated with molybdate anions for electrocatalytic water oxidation,” *Journal of Materials Chemistry A*, 3(2015)16348–16353.
- [314] Y. Hu, Z. Wang, W. Liu, L. Xu, M. Guan, Y. Huang, Y. Zhao, J. Bao, H. Li, “Novel Cobalt–Iron–Vanadium Layered Double Hydroxide Nanosheet Arrays for Superior Water Oxidation Performance,” *ACS Sustainable Chemistry & Engineering*, 7(2019)16828–16834.

PUBLICATION LIST

(i) Deciphering Ligand Controlled Structural Evolution of Prussian Blue Analogues and Their Electrochemical Activation during Alkaline Water Oxidation

Baghendra Singh, Pandian Mannu, Yu-Cheng Huang, Ravi Prakash, Shaohua Shen, Chung-Li Dong, Arindam Indra

Angew. Chem. Int. Ed. **2022**, *61*, e202211585.

(ii) Electrochemical transformation of Prussian blue analogues into ultrathin layered double hydroxide nanosheets for water splitting

Baghendra Singh, Om Prakash, Pralay Maiti, Prashanth W. Menezes, Arindam Indra

Chem. Commun. **2020**, *56*, 15036-15039.

(iii) Electrochemical transformation of metal-organic framework into ultrathin metal hydroxide-(oxy)hydroxide nanosheets for alkaline water oxidation

Baghendra Singh, Om Prakash, Pralay Maiti, Arindam Indra

ACS Appl. Nano Mater. **2020**, *3*, 6693-6701.

(iv) Prussian blue-and Prussian blue analogue-derived materials: Progress and prospects for electrochemical energy conversion

Baghendra Singh, Arindam Indra

Mater. Today Energy. **2020**, *16*, 100404.

(v) Surface and interface engineering in transition metal-based catalysts for electrochemical water oxidation

Baghendra Singh, Arindam Indra

Mater. Today Chem. **2020**, *16*, 100239.

(vi) Role of redox active and redox non-innocent ligands in water splitting

Baghendra Singh, Arindam Indra

Inorg. Chim. Acta. **2020**, *506*, 119440.

(vii) Designing self-supported metal-organic framework derived ccatalysts for electrochemical water splitting

Baghendra Singh, Arindam Indra

Chem. Asian J. **2020**, *15*, 607-623.

(viii) Tuning the properties of CoFe-layered double hydroxide by vanadium substitution for improved water splitting activity

Baghendra Singh, Arindam Indra

Dalton Trans. **2021**, *50*, 2359-2363.

(ix) Modulating electronic structure of metal-organic framework derived catalysts for electrochemical water oxidation

Baghendra Singh, Amrendra Singh, Abhimanyu Yadav, Arindam Indra

Coord. Chem. Rev. **2021**, *447*, 214144.

(x) Introduction of high valent Mo⁶⁺ in Prussian blue analog derived Co-layered double hydroxide nanosheets for improved water splitting

Baghendra Singh, Atri Kumar Patel, Arindam Indra

Mater. Today Chem. **2022**, *25*, 100930.

(xi) Realizing Electrochemical Transformation of Metal-Organic Framework Precatalyst into Metal Hydroxide-Oxy (hydroxide) Active Catalyst During Alkaline Water Oxidation

Baghendra Singh, Abhimanyu Yadav, Arindam Indra

J. Mater. Chem. A **2022**, *10*, 3843-3868.

(xii) Ruthenium–benzothiadiazole building block derived dynamic heterometallic Ru–Ag coordination polymer and its enhanced water-splitting feature

Sanchaita Dey, **Baghendra Singh**, Souradip Dasgupta, Anindya Dutta, Arindam Indra, Goutam Kumar Lahiri

Inorg. Chem. **2021**, *60*, 9607-9620.

(xiii) Exploring the mechanism of peroxodisulfate activation with silver metavanadate to generate abundant reactive oxygen species

Ajit Kumar Singh, Dirk Hollmann, Michael Schwarze, Chakadola Panda, **Baghendra Singh**, Prashanth W. Menezes, Arindam Indra

Adv. Sustain. Sys. **2021**, *5*, 2000288.

(xiv) Replacing anodic oxygen evolution reaction with organic oxidation: The importance of metal (oxy)hydroxide formation as the active oxidation catalyst

Ajit Kumar Singh, Deepak Kumar, **Baghendra Singh**, Arindam Indra

Synlett. **2022**, *33*, ST-2022-b0192

(xv) Alkaline oxygen evolution: Exploring synergy between fcc and hcp cobalt nanoparticles entrapped in N-doped graphene

Ajit Kumar Singh, Selugi Ji, **Baghendra Singh**, Chittaranjan Das, Hechae Choi, Prashanth W. Menezes, Arindam Indra

Mater. Today Chem. **2022**, *23*, 100668.

(xvi) Homoleptic Ni(II) dithiocarbamate complexes as pre-catalysts for electrocatalytic oxygen evolution reaction

Sarvesh Kumar Pal, **Baghendra Singh**, Jitendra Yadav, Chote Lal Yadav, Michael G. B. Drew, Nanhai Singh, Arindam Indra, Kamlesh Kumar

Dalton Trans. **2022**, *51*, 13003-13014.

(xvii) Ruthenium Azobis (benzothiazole): Electronic Structure and Impact of Substituents on the Electrocatalytic Single-Site Water Oxidation Process

Aditi Singh, **Baghendra Singh**, Sanchaita Dey, Arindam Indra, Goutam Kumar Lahiri

Inorg. Chem. **2023**, *62*, 2769-2783.

(xviii) Chlorocobaloxime containing N-(4-pyridylmethyl)-1,8-naphthalamide peripheral ligands: synthesis, characterization and enhanced electrochemical hydrogen evolution in alkaline medium

Jitendra Kumar Yadav, **Baghendra Singh**, Sarvesh Kumar Pal, Nanhai Singh, Prem Lama, Arindam Indra, Kamlesh Kumar

Dalton Trans. **2023**, 52, 936-946.