

# Won-Jin Kwak, Ph.D.

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& Department of Energy Systems Research  
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## EDUCATION

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- Ph.D. Hanyang University**, Seoul, Republic of Korea 2/2018  
Department of Energy Engineering,  
Thesis title: Lithium halides as redox mediators for lithium oxygen batteries  
Principal Investigator: Prof. Yang-Kook Sun
- B.A. Hanyang University**, Seoul, Republic of Korea 2/2012  
Department of Chemical Engineering

## EXPERIENCES

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- Assistant Professor** 2020-Present  
Electrochemical Materials & System Design Laboratory  
Department of Chemistry & Department of Energy Systems Research, Ajou University  
Woncheon Hall 215-3, Ajou University, Suwon, 16499, Republic of Korea
- Postdoctoral Research Associate** 2019-2020  
Battery Materials and Systems Group (Principal Investigator: Dr. Jason Zhang & Dr. Wu Xu)  
Energy and Environment Directorate, Pacific Northwest National Laboratory (PNNL)  
Richland, Washington 99354, United States
- Postdoctoral Researcher** 2018-2019  
Energy Storage & Conversion Materials Lab. (Principal Investigator: Prof. Yang-Kook Sun)  
Department of Energy Engineering, Hanyang University  
Seoul, Republic of Korea

## SELECTED PUBLICATIONS

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- ♦ Joo-Eun Kim et al. "Acceleration of Singlet Oxygen Evolution by Superoxide Dismutase Mimetics in Lithium–Oxygen Batteries." *Adv. Funct. Mater.*, 32, 2209012 (2022).
- ♦ Ji-Su Woo et al. "Liquid metal arene complex for next-generation batteries." *Mater. Today Energy.*, 101156 (2022).
- ♦ Hyun-Wook Lee et al. "Ambilaterality of RM towards  $^1\text{O}_2$  in Li-O<sub>2</sub> batteries: trap and quencher." *Adv. Funct. Mater.*, 31, 2102442 (2021).
- ♦ W.-J. Kwak et al. "Lithium-Oxygen Batteries and Related Systems: Potential, Status and Future." *Chem. Rev.*, 120, 6626 (2020).
- ♦ W.-J. Kwak et al. "Optimized Electrolyte with High Electrochemical Stability and Oxygen Solubility for Lithium–Oxygen and Lithium–Air Batteries." *ACS Energy Lett.*, 5, 2182 (2020).
- ♦ Won-Jin Kwak et al. "Oxidation Stability of Organic Redox Mediators as Mobile Catalysts in Lithium–Oxygen Batteries." *ACS Energy Lett.*, 5, 2122-2129 (2020).
- ♦ W.-J. Kwak et al. "Deactivation of redox mediators in lithium-oxygen batteries by singlet oxygen." *Nat. Commun.*, 10, 1380 (2019) 'Selected as editor's highlight'.

## EXPERTISE & RESEARCH EXPERIMENTS

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- **Next-Generation Batteries:** Lithium-oxygen battery, Beyond Li batteries (Na/K/Zn/Al), Aqueous batteries
- **Recycling:** Direct electrode recycling (upcycling), Lithium extraction, Battery recovery
- **Electrolyte Design:** Molecular reconstitution, SEI control, Functional additive, Solid electrolyte
- **In-Situ Analysis :** Differential Electrochemical Mass Spectrometer (gas), In-situ optical microscope

## JOURNAL PUBLICATIONS

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**Total 51 papers (33 lead-authored papers), Citation: 2757, h-index: 28**

(† equal contribution, \* corresponding author).

### 2022

51. Joo-Eun Kim, Hyun-Wook Lee, **Won-Jin Kwak**\* "Acceleration of Singlet Oxygen Evolution by Superoxide Dismutase Mimetics in Lithium–Oxygen Batteries" *Adv. Funct. Mater.*, 32, 2209012 (2022) <https://doi.org/10.1002/adfm.202209012>.
50. Ji-Su Woo, Hyun-Wook Lee, Ji-Hee Lee, Seung-Hun Han, **Won-Jin Kwak**\*. "Liquid metal arene complex for next-generation batteries." *Mater. Today Energy.*, 101156 (2022) <https://doi.org/10.1016/j.mtener.2022.101156>.
49. Min-Gi Jeong†, **Won-Jin Kwak**†, Ji Young Kim, Joong Kee Lee, Yang-Kook Sun\*, Hun-Gi Jung\*. "Uniformly Distributed Reaction by 3D Host-Lithium Composite Anode for High Rate Capability and Reversibility of Li-O<sub>2</sub> Batteries" *Chem. Eng. J.*, 427, 130914 (2022) <https://doi.org/10.1016/j.cej.2021.130914>.

### 2021

48. Hyung-Seok Lim†, **Won-Jin Kwak**†, Sujong Chae, Sungun Wi, Linze Li, Jinagtao Hu, Jinhui Tao, Chongmin Wang, Wu Xu\*, Ji-Guang Zhang\*. "Stable Solid Electrolyte Interphase Layer Formed by Electrochemical Pretreatment of Gel Polymer Coating on Li Metal Anode for Lithium–Oxygen Batteries" *ACS Energy Lett.*, 6, 3321–3331 (2021) <https://doi.org/10.1021/acseenergylett.1c01144>.
47. Hyun-Wook Lee†, Hun Kim†, Hun-Gi Jung, Yang-Kook Sun\*, **Won-Jin Kwak**\*. "Ambilaterality of RM towards <sup>1</sup>O<sub>2</sub> in Li-O<sub>2</sub> batteries: trap and quencher" *Adv. Funct. Mater.*, 31, 2102442 (2021) <https://doi.org/10.1002/adfm.202102442>.
46. Sujong Chae, **Won-Jin Kwak**, Kee Sung Han, Shuang Li, Mark H. Engelhard, Jiangtao Hu, Chongmin Wang, Xiaolin Li\*, Ji-Guang Zhang\*. "Rational Design of Electrolytes for Long-Term Cycling of Si Anodes in Wide Temperature Range." *ACS Energy Lett.*, 6, 387-394 (2020) <https://doi.org/10.1021/acseenergylett.0c02214>.

### 2020

45. Jimin Park, Jang-Yeon Hwang\*, **Won-Jin Kwak**\*. "Potassium-Oxygen Batteries: Significance, Challenges, and Prospects." *J. Phys. Chem. Lett.*, 11, 7849-7856 (2020) <https://doi.org/10.1021/acs.jpcclett.0c01596>.
44. Hyeon-Ji Shin†, Jang-Yeon Hwang†, Hyun Jung Kwon, **Won-Jin Kwak**, Hun-Gi Jung\*. "Sustainable Encapsulation Strategy of Silicon Nanoparticles in Microcarbon Sphere for High-Performance Lithium-Ion Battery Anode." *ACS Sustainable Chem. Eng.*, 8, 14150-14158 (2020) <https://doi.org/10.1021/acssuschemeng.0c04828>.
43. Jinhong Lee, Hyung-Seok Lim, Xia Cao, **Won-Jin Kwak**, Xiaodi Ren, Ji-Guang Zhang, Hongkyung Lee\*, Hee-Tak Kim\*. "Lithium Dendrite Suppression with Silica Nanoparticle-Dispersed Colloidal Electrolyte." *ACS Appl. Mater. Interfaces*, 12, 37188-37196 (2020) <https://pubs.acs.org/doi/10.1021/acsaami.0c09871>.
42. **Won-Jin Kwak**, Hyung-Seok Lim, Peiyuan Gao, Ruozhu Feng, Sujong Chae, Lirong Zhong, Jeffrey Read, Mark H. Engelhard, Wu Xu\*, Ji-Guang Zhang\*. "Effects of Fluorinated Diluents in Localized High-Concentration Electrolytes for Lithium-Oxygen Batteries." *Adv. Funct. Mater.*, 30, 2002927 (2020) <https://doi.org/10.1002/adfm.202002927>.

41. **Won-Jin Kwak**, Sujong Chae, Ruozhu Feng, Peiyuan Gao, Jeffrey Read, Mark H. Engelhard, Lirong Zhong, Wu Xu\*, Ji-Guang Zhang\*. "Optimized Electrolyte with High Electrochemical Stability and Oxygen Solubility for Lithium-Oxygen and Lithium-Air Batteries." *ACS Energy Lett.*, 5, 2182-2190 (2020) <https://doi.org/10.1021/acsenergylett.0c00809>.
40. **Won-Jin Kwak**†, Jiwon Park†, Hun Kim†, Jung Min Joo, Doron Aurbach\*, Hye Ryung Byon\*, Yang-Kook Sun\*. "Oxidation Stability of Organic Redox Mediators as Mobile Catalysts in Lithium–Oxygen Batteries." *ACS Energy Lett.*, 5, 2122-2129 (2020) <https://doi.org/10.1021/acsenergylett.0c00883>
39. Min-Gi Jeong†, **Won-Jin Kwak**†, Hyeon-Ji Shin, Yang-Kook Sun\*, Hun-Gi Jung\*. "Perpendicularly Aligned TiC-Coated Carbon Cloth Cathode for High-Performance Li-O<sub>2</sub> Batteries." *Chem. Eng. J.*, 399, 125699 (2020) <https://doi.org/10.1016/j.cej.2020.125699>
38. Jimin Park†, Jun Lee†, Muhammad Hilmy Alfaruqi, **Won-Jin Kwak**, Jaekook Kim\*, Jang-Yeon Hwang\*. "Initial estimation and diagnosis of potassium metal as anode for rechargeable potassium batteries." *J. Mater. Chem. A*, 8, 16718-16737 (2020) <https://doi.org/10.1039/D0TA03562A>.
37. **Won-Jin Kwak**†, Rosy†, Daniel Sharon, Chun Xia, Hun Kim, Lee R. Johnson, Peter G. Bruce\*, Linda F. Nazar\*, Yang-Kook Sun\*, Aryeh A. Frimer, Malachi Noked, Stefan A. Freunberger, Doron Aurbach\*. "Lithium-Oxygen Batteries and Related Systems: Potential, Status and Future." *Chem. Rev.*, 120, 6626-6683 (2020) <https://doi.org/10.1021/acs.chemrev.9b00609>.
36. Hun Kim, **Won-Jin Kwak**, Hun-Gi Jung, Yang-Kook Sun\*. "Limited effect of redox mediator in lithium-oxygen batteries: Indecomposable by-products." *J. Mater. Chem. A*, 8, 5622-5628 (2020) <https://doi.org/10.1039/C9TA13612F>.
35. **Won-Jin Kwak**, Atif Mahammed, Hun Kim, Trung Thien Nguyen, Zeev Gross\*, Doron Aurbach\*, Yang-Kook Sun\*. "Controllable and Stable Organometallic Redox Mediators for Lithium Oxygen Batteries." *Mater. Horiz.*, 7, 214-222 (2020) <https://doi.org/10.1039/C9MH01043B>.

## 2019

34. **Won-Jin Kwak**, Stefan A. Freunberger, Hun Kim, Jiwon Park, Trung Thien Nguyen, Hun-Gi Jung, Hye Ryung Byon, Yang-Kook Sun\*. "Mutual Conservation of Redox Mediator and Singlet Oxygen Quencher in Lithium-Oxygen Batteries." *ACS Catal.*, 9, 9914-9922 (2019) <https://doi.org/10.1021/acscatal.9b01337>.
33. **Won-Jin Kwak**, Hun Kim, Trung Thien Nguyen, Yann K. Petit, Nika Mahne, Christian Leypold, Paul Redfern, Larry A. Curtiss, Hun-Gi Jung, Sergey M. Borisov, Stefan A. Freunberger\*, Yang-Kook Sun\*. "Deactivation of redox mediators in lithium-oxygen batteries by singlet oxygen." *Nat. Commun.*, 10, 1380 (2019). 'Selected as editor's highlight' <https://doi.org/10.1038/s41467-019-09399-0>.
32. Hun Kim, **Won-Jin Kwak**, Hun-Gi Jung, Yang-Kook Sun\*. "Verification for trihalide ions as redox mediators in Li-O<sub>2</sub> batteries." *Energy Storage Materials*, 19, 148-153 (2019) <https://doi.org/10.1016/j.ensm.2019.02.025>.
31. Min-Gi Jeong†, **Won-Jin Kwak**†, Mobinul Islam, Jiwon Park, Hye Ryung Byon, Minchul Jang, Yang-Kook Sun\*, Hun-Gi Jung\*. "Triple Hierarchical Porous Carbon Spheres as Effective Cathodes for Li–O<sub>2</sub> Batteries." *J. Electrochem. Soc.*, 166, A455-A463 (2019) <https://doi.org/10.1149/2.0021904jes>.
30. **Won-Jin Kwak**, Jiwon Park, Trung Thien Nguyen, Hun Kim, Hye Ryung Byon, Minchul Jang, Yang-Kook Sun\*. "A dendrite- and oxygen-proof protective layer for lithium metal in lithium-oxygen batteries." *J. Mater. Chem. A*, 7, 3857-3862 (2019) <https://doi.org/10.1039/C8TA11941D>.

## 2018

29. **Won-Jin Kwak**, Nam-Yung Park, Yang-Kook Sun\*. "ICAC 2018: The First International Conference Focused on NCM & NCA Cathode Materials for Lithium Ion Batteries." *ACS Energy Lett.*, 3, 2757-2760 (2018) <https://doi.org/10.1021/acsenergylett.8b01926>.
28. **Won-Jin Kwak**, Hun Kim, Hun-Gi Jung, Doron Aurbach\*, Yang-Kook Sun\*. "A Comparative Evaluation of Redox Mediators for Li-O<sub>2</sub> Batteries: A Critical Review." *J. Electrochem. Soc.*, 165, A2274-A2293 (2018) <https://doi.org/10.1149/2.0901810jes>.
27. Daniel Hirshberg, Daniel Sharon, Michal Afri, Ronit Lavi, Aryeh A. Frimer, Noa Metoki, Noam Eliaz, **Won-Jin Kwak**, Yang-Kook Sun, Doron Aurbach\*. "Shedding Light on the Oxygen Reduction Reaction

Mechanism in Ether-Based Electrolyte Solutions: A Study Using Operando UV–Vis Spectroscopy." *ACS Appl. Mater. Interfaces*, 10, 10860-10869 (2018) <https://doi.org/10.1021/acsami.7b18376>.

26. **Won-Jin Kwak**†, Seong-Jin Park†, Hun-Gi Jung, Yang-Kook Sun\*. "Optimized Concentration of Redox Mediator and Surface Protection of Li Metal for Maintenance of High Energy Efficiency in Li-O<sub>2</sub> Batteries." *Adv. Energy Mater.*, 8, 1702258 (2018) <https://doi.org/10.1002/aenm.201702258>.

25. **Won-Jin Kwak**†, Langli Luo†, Hun-Gi Jung, Chongmin Wang\*, Yang-Kook Sun\*. "Revealing the Reaction Mechanism of Na-O<sub>2</sub> Batteries using Environmental Transmission Electron Microscopy." *ACS Energy Lett.*, 3, 393-399 (2018) <https://doi.org/10.1021/acsenergylett.7b01273>.

24. Young Joo Lee†, **Won-Jin Kwak**†, Yang-Kook Sun\*, Yun Jung Lee\*. "Clarification of Solvent Effects on Discharge Products in Li-O<sub>2</sub> Batteries through a Titration Method." *ACS Appl. Mater. Interfaces*, 10, 526-533 (2018) <https://doi.org/10.1021/acsami.7b14279>.

## 2017

23. **Won-Jin Kwak**, Jin-Bum Park, Hun-Gi Jung, Yang-Kook Sun\*. "Controversial Topics on Lithium Superoxide in Li-O<sub>2</sub> Batteries." *ACS Energy Lett.*, 2, 2756-2760 (2017) <https://doi.org/10.1021/acsenergylett.7b00985>.

22. **Won-Jin Kwak**†, Sung Hoon Ha†, Do Hyung Kim, Kyu Hang Shin, Yang-Kook Sun\*, Yun Jung Lee\*. "Synergistic Integration of Soluble Catalysts with Carbon-Free Electrodes for Li-O<sub>2</sub> Batteries." *ACS Catal.*, 7, 8192-8199 (2017) <https://doi.org/10.1021/acscatal.7b02359>.

21. Jin-Hyuk Kang†, **Won-Jin Kwak**†, Doron Aurbach, Yang-Kook Sun\*. "Sodium oxygen batteries: one step further with catalysis by ruthenium nanoparticles." *J. Mater. Chem. A*, 5, 20678-20686 (2017) <https://doi.org/10.1039/C7TA06584A>.

20. Daniel Sharon, Pessia Sharon, Daniel Hirshberg, Michael Salama, Michal Afri, Linda J. W. Shimon, **Won-Jin Kwak**, Yang-Kook Sun, Aryeh A. Frimer, Doron Aurbach\*. "2,4-Dimethoxy-2,4-dimethylpentan-3-one: An Aprotic Solvent Designed for Stability in Li–O<sub>2</sub> Cells." *J. Am. Chem. Soc.*, 139, 11690-11693 (2017) <https://doi.org/10.1021/jacs.7b06414>.

19. **Won-Jin Kwak**, Hun-Gi Jung, Doron Aurbach\*, Yang-Kook Sun\*. "Optimized Bicompartement Two Solution Cells for Effective and Stable Operation of Li-O<sub>2</sub> Batteries." *Adv. Energy Mater.*, 7, 1701232 (2017) <https://doi.org/10.1002/aenm.201701232>.

18. Seon Hwa Lee, **Won-Jin Kwak**, Yang-Kook Sun\*. "A new perspective of the ruthenium ion: a bifunctional soluble catalyst for high efficiency Li-O<sub>2</sub> batteries." *J. Mater. Chem. A*, 5, 15512-15516 (2017) <https://doi.org/10.1039/C7TA04070A>.

17. Hyeon-Ji Shin, **Won-Jin Kwak**, Doron Aurbach, Yang-Kook Sun\*. "Large-Scale Li-O<sub>2</sub> Pouch Type Cells for Practical Evaluation and Applications." *Adv. Funct. Mater.*, 27, 1605500 (2017) <https://doi.org/10.1002/adfm.201605500>.

16. Daniel Hirshberg, Daniel Sharon, Ezequiel De La Llave, Michal Afri, Aryeh A. Frimer, **Won-Jin Kwak**, Yang-Kook Sun, Doron Aurbach\*. "Feasibility of Full (Li-Ion)-O<sub>2</sub> Cells Comprised of Hard Carbon Anodes." *ACS Appl. Mater. Interfaces*, 9, 4352-4361 (2017) <https://doi.org/10.1021/acsami.6b10974>.

## 2016

15. **Won-Jin Kwak**, Hyeon-Ji Shin, Jakub Reiter, Nikolaos Tsiouvaras, Jusef Hassoun, Stefano Passerini, Bruno Scrosati, Yang-Kook Sun\*. "Understanding problems of lithiated anode in lithium oxygen full cells." *J. Mater. Chem. A*, 4, 10467-10471 (2016) <https://doi.org/10.1039/C6TA03013K>.

14. **Won-Jin Kwak**, Daniel Hirshberg, Daniel Sharon, Michal Afri, Aryeh A. Frimer, Hun-Gi Jung, Doron Aurbach, Yang-Kook Sun. "Li–O<sub>2</sub> cells with LiBr as an electrolyte and a redox mediator." *Energy Environ. Sci.*, 9, 2334-2345 (2016) <https://doi.org/10.1039/C6EE00700G>.

13. Daniel Sharon, Daniel Hirsberg, Michael Salama, Michal Afri, Aryeh A. Frimer, Malachi Noked, **Won-Jin Kwak**, Yang-Kook Sun, Doron Aurbach\*. "Mechanistic Role of Li<sup>+</sup> Dissociation Level in Aprotic Li-O<sub>2</sub> Battery." *ACS Appl. Mater. Interfaces*, 8, 5300-5307 (2016) <https://doi.org/10.1021/acsami.5b11483>.

12. **Won-Jin Kwak**†, Tae-Geun Kang†, Yang-Kook Sun\*, Yun Jung Lee\*. "Iron–cobalt bimetal decorated carbon nanotubes as cost-effective cathode catalysts for Li-O<sub>2</sub> batteries." *J. Mater. Chem. A*, 4, 7020-7026

(2016) <https://doi.org/10.1039/C5TA10550A>.

11. **Won-Jin Kwak**<sup>†</sup>, Hun-Gi Jung<sup>†</sup>, Seon-Hwa Lee, Jin-Bum Park, Doron Aurbach\*, Yang-Kook Sun\*. "Silver nanowires as catalytic cathodes for stabilizing lithium-oxygen batteries." *J. Power Sources*, 311, 49-56 (2016) <https://doi.org/10.1016/j.jpowsour.2016.02.021>.

## 2015

10. Hai Ming, Pushpendra Kumar, Wenjing Yang, Yu Fu, Jun Ming\*, **Won-Jin Kwak**, Lain-Jong Li, Yang-Kook Sun\*, Junwei Zheng\*. "Green Strategy to Single Crystalline Anatase TiO<sub>2</sub> Nanosheets with Dominant (001) Facets and Its Lithiation Study toward Sustainable Cobalt-Free Lithium Ion Full Battery." *ACS Sustainable Chem. Eng.*, 3, 3086-3095 (2015) <https://doi.org/10.1021/acssuschemeng.5b00553>.

9. **Won-Jin Kwak**, Daniel Hirshberg, Daniel Sharon, Hyeon-Ji Shin, Michal Afri, Jin-Bum Park, Arnd Garsuch, Frederick Francois Chesneau, Aryeh A. Frimer, Doron Aurbach\*, Yang-Kook Sun\*. "Understanding the behavior of Li–oxygen cells containing LiI." *J. Mater. Chem. A*, 3, 8855-8864 (2015) <https://doi.org/10.1039/C5TA01399B>.

8. **Won-Jin Kwak**, Kah Chun Lau, Chang-Dae Shin, Khalil Amine, Larry A Curtiss\*, Yang-Kook Sun\*. "A Mo<sub>2</sub>C/Carbon Nanotube Composite Cathode for Lithium-Oxygen Batteries with High Energy Efficiency and Long Cycle Life." *ACS Nano*, 9, 4129-4137 (2015) <https://doi.org/10.1021/acsnano.5b00267>.

7. Hai Ming, Jun Ming, **Won-Jin Kwak**, Wenjing Yang, Qun Zhou, Junwei Zheng, Yang-Kook Sun\*. "Fluorine-doped porous carbon-decorated Fe<sub>3</sub>O<sub>4</sub>-FeF<sub>2</sub> composite versus LiNi<sub>0.5</sub>Mn<sub>1.5</sub>O<sub>4</sub> towards a full battery with robust capability." *Electrochim. Acta*, 169, 291-299 (2015) <https://doi.org/10.1016/j.electacta.2015.04.108>.

6. Jun Ming\*, Hai Ming, Wenjing Yang, **Won-Jin Kwak**, Jin-Bum Park, Junwei Zheng, Yang-Kook Sun\*. "A sustainable iron-based sodium ion battery of porous carbon–Fe<sub>3</sub>O<sub>4</sub>/Na<sub>2</sub>FeP<sub>2</sub>O<sub>7</sub> with high performance." *RSC Adv.*, 5, 8793-8800 (2015) <https://doi.org/10.1039/C4RA14733B>.

5. **Won-Jin Kwak**, Zonghai Chen, Chong Seung Yoon, Joong-Kee Lee, Khalil Amine, Yang-Kook Sun\*. "Nanoconfinement of low-conductivity products in rechargeable sodium–air batteries." *Nano Energy*, 12, 123-130 (2015) <https://doi.org/10.1016/j.nanoen.2014.11.057>.

## 2014

4. Jun Ming, **Won-Jin Kwak**, Sung-Jun Youn, Hai Ming, Jusef Hassoun\*, Yang-Kook Sun\*. "Lithiation of an Iron Oxide-Based Anode for Stable, High-Capacity Lithium-Ion Batteries of Porous Carbon–Fe<sub>3</sub>O<sub>4</sub>/Li[Ni<sub>0.59</sub>Co<sub>0.16</sub>Mn<sub>0.25</sub>]O<sub>2</sub>." *Energy Technol.*, 2, 778-785 (2014) <https://doi.org/10.1002/ente.201402031>.

3. Giuseppe Antonio Elia, Jusef Hassoun\*, **Won-Jin Kwak**, Yang-Kook Sun\*, Bruno Scrosati\*, Franziska Mueller, Dominic Bresser, Stefano, Passerini\*, Philipp Oberhumer, Nikolaos Tsiouvaras, Jakub Reiter. "An Advanced Lithium–Air Battery Exploiting an Ionic Liquid-Based Electrolyte." *Nano Lett.*, 14, 6572–6577 (2014) <https://doi.org/10.1021/nl5031985>.

2. Jun Ming, Hai Ming, **Won-Jin Kwak**, Chang-dae Shin, Junwei Zheng, Yang-Kook Sun\*. "The effect on an oxide-based anode in lithium and sodium-ion battery applications: the fastest way to ultrahigh performance." *Chem. Commun.*, 50, 13307-13310 (2014) <https://doi.org/10.1039/C4CC02657H>.

1. Jun Ming<sup>†</sup>, **Won-Jin Kwak**<sup>†</sup>, Jin-Bum Park, Chang-Dae Shin, Jun Lu, Larry Curtiss, Khalil Amine, Yang-Kook Sun\*. "A Physical Pulverization Strategy for Preparing a Highly Active Composite of CoO<sub>x</sub> and Crushed Graphite for Lithium–Oxygen Batteries." *ChemPhysChem*, 15, 2070-2076 (2014) <https://doi.org/10.1002/cphc.201400054>.

## PATENTS

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5. **Won-Jin Kwak**, Yang-Kook Sun. "Metal oxygen batteries using redox mediator and singlet oxygen quencher." Patent application 10-2018-0046785 (South Korea, 2018.04.23.)

4. **Won-Jin Kwak**, Seong-Jin Park, Yang-Kook Sun. "Graphene-polydopamine composite layer coating for

stabilization of Li metal electrode surface.” Patent application 10-2017-0121385 (South Korea, 2017.09.20.)

3. **Won-Jin Kwak**, Yang-Kook Sun. “Electrolyte additive for lithium metal protection in Li-O<sub>2</sub> battery” Patent registration 10-2470559-0000 (South Korea, 2022.11.21.), Patent application 10-2016-0063855 (South Korea, 2016.05.25.)

2. **Won-Jin Kwak**, Yang-Kook Sun. “Mo<sub>2</sub>C/CNT composite as air electrode of lithium-air battery.” Patent registration 10-1674736 (South Korea, 2016.11.03.), Patent application 10-2014-0132953 (South Korea, 2014.10.02.), Patent application 15/477,793 (USA, 2017.04.03.)

1. **Won-Jin Kwak**, Jin-Bum Park, Yang-Kook Sun. “Reaction of LiI with Li<sub>2</sub>O<sub>2</sub>, and lithium-air batteries using the reaction.” Patent application 10-2015-0124853 (South Korea, 2017.09.03.), Patent application 15/448,778 (USA, 2017.03.03.), Patent application 201580047438.8 (China, 2017.03.03.), Patent application 15837357.1 (EU, 2017.03.03.)

## RESEARCH PROJECTS

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|---|--------------|
| <b>10. Priority Research Institute Program</b><br>Fund: NRF, South Korea<br>Principal Investigator: Prof. Won-Jin Kwak<br>Individual research focus: New electrolyte additives for Li-air batteries   | 2021~present |
| <b>9. POSCO Science Fellow (2020) / Energy Materials</b><br>Fund: POSCO TJ Park Foundation, South Korea<br>Principal Investigator: Prof. Won-Jin Kwak<br>Individual research focus: Functional electrolytes for aqueous batteries   | 2021~present |
| <b>8. Young Scientist Research Grant</b><br>Fund: NRF, South Korea<br>Principal Investigator: Prof. Won-Jin Kwak<br>Individual research focus: Liquid electrodes based batteries  | 2021~present |
| <b>7. Settlement Support for New Faculty at Ajou University (S rank)</b><br>Fund: Ajou University, South Korea<br>Principal Investigator: Prof. Won-Jin Kwak<br>Individual research focus: Rechargeable Lithium-air batteries, Li-CO <sub>2</sub> batteries, K metal batteries  | 2020~2022    |
| <b>6. BMR Project (Exploratory Electrode Materials for High Energy Batteries)</b><br>Fund: Department of Energy (U.S. DoE), United States.<br>Principal Investigator: Dr. Ji-Guang Zhang and Dr. Wu Xu<br>Individual research focus: Rechargeable Lithium-air batteries, Li metal protection, Electrolyte reformation | 2019~2020    |
| <b>5. Postdoctoral researcher support project</b><br>Fund: Hanyang University, South Korea<br>Principal Investigator: Prof. Yang-Kook Sun<br>Individual research focus: Lithium air battery with high efficient and stable soluble additives (redox mediator) by verification of degradation mechanism and solutions  | 2018~2019    |
| <b>4. Next Generation lithium ion battery GET-Future Lab.</b><br>Fund: Korea Institute of Energy Technology Evaluation and Planning (KETEP) (No. 20154010200840)<br>Principal Investigator: Prof. Yang-Kook Sun   | 2012~2019    |

Individual research focus: Verification of degradation mechanism (superoxide, singlet oxygen chemistry), Cell system development, Electrolyte additive (redox mediator), In-situ analysis (Environmental transmission electron microscopy, On-line electrochemical mass spectrometry)

**3. Development of high-efficiency cathode and analysis of mechanism for lithium-air batteries** 2016~2019

Fund: LG Chemical, South Korea

Principal Investigator: Prof. Yang-Kook Sun

Individual research focus: Catalytic cathode, Li metal protection, Electrolyte additive (redox mediator)

**2. Research consultation for lithium-air batteries**

2014

Fund: HYUNDAI Motor, South Korea

Principal Investigator: Prof. Yang-Kook Sun

Individual research focus: Consultation and pretest of materials for research team in HYUNDAI Motor

**1. Development of safe and efficient electrodes for lithium-air batteries**

2013~2015

Fund: BMW, Germany

Principal Investigator: Prof. Yang-Kook Sun

Individual research focus: Silicon anode, Ionic electrolyte, Gel polymer electrolyte, Li-O<sub>2</sub> full cell

## **PRESENTATIONS (Oral)**

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19. **Won-Jin Kwak**. "Toward Deficient-Free Lithium-Oxygen Batteries. **2022 Fall Meeting of the Korean Institute of Chemical Engineers**, Busan, South Korea, Oct 27, 2022.

18. **Won-Jin Kwak**. "Development of Anti-Reactive Oxygen Species for Lithium-Oxygen Batteries" **2022 Latest R&D trend of secondary battery forum at UNIST**, Ulsan, South Korea, Sep 23, 2022.

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