# Dr Qilei Song

**Department of Chemical Engineering, Imperial College London, London SW7 2AZ, United Kingdom**
**Website:** www.imperial.ac.uk/people/q.song **Group website:** www.imperial.ac.uk/song-group
**Phone: +44 (0)20 7594 5623** **Email: q.song@imperial.ac.uk**

**Research interests**

- Design and synthesis of functional polymers and nanoporous materials
- Membrane materials and separation processes, e.g. gas separation, water purification, and chemical separations
- Ion-exchange membrane materials for energy conversion and storage, and environmental processes
- Functional energy materials for electrochemical energy conversion and storage processes.

**Current position**

2023-present Reader in Chemical Engineering (Associate Professor), Department of Chemical Engineering, Imperial College London, UK
Group leader, Functional Membranes and Energy Materials Research Group
Principal investigator, ***Barrer Centre***, a world-leading centre focusing on separation materials and membrane technology at Imperial College.

2020- 2023 Senior Lecturer, Department of Chemical Engineering, Imperial College London, UK

2016 – 2020 Lecturer, Department of Chemical Engineering, Imperial College London, UK

**Previous positions**

2014 – 2016 Imperial College Junior Research Fellow, independent fellowship
Department of Chemical Engineering, Imperial College London, UK
Project title: *Design and Fabrication of Molecularly Defined Functional Materials*
Mentor: Prof. Andrew Livingston FRS FREng, Director of Barrer Centre

2013– 2014 Postdoctoral Research Associate
Cavendish Laboratory, Department of Physics, University of Cambridge, United Kingdom

**Education**

2014 PhD in Physics, Cavendish Laboratory, Department of Physics, University of Cambridge
**PhD advisors:** Prof Easan Sivaniah (now at Kyoto University), Prof. Eugene Terentjev, Sir Prof. Anthony K. Cheetham FRS.
**PhD thesis title**: Polymer molecular sieve membranes for gas separation.

2009-2010 PhD in Chemical Engineering (transferred after one year), Department of Chemical Engineering, University of Cambridge
**Advisor:** Prof. John S. Dennis, Head of School of Technology, University of Cambridge

2006-2009 Master in Energy and Environmental Engineering
School of Energy and Environment, Southeast University, Nanjing, China
**Advisor:** Prof. Rui Xiao, Dean of School of Energy and Environment.

2002-2006 Bachelor in Energy Engineering
School of Energy and Environment, Southeast University, Nanjing, China

**Grants**

I have attracted about £4 Million as principal investigator since I started my independent career, including the prestigious ERC Starting Grant and EPSRC Programme Grant.

1. **PI on EPSRC grant (ERC Proof of Concept grant).** Upscaling and Manufacturing of Ion-Selective Membranes for Energy Storage (IonMembrane). 1/4/2023-31/10/2024. £127,041. https://www.imperial.ac.uk/news/243131/two-imperial-engineers-european-grants-pioneering/
2. **PI on UKRI Impact Acceleration grant.** Upscaling and Manufacturing of Polymer Membranes. 1/2/2023-31/1/2024. £100k.
3. **PI on Mark Richardson Fund, PhD studentship.** Electrodialysis membrane separation processes for plastic recycling. 1/3/2023-31/8/2026. £200k.
4. **PI on ERC Starting Grant.** Design and NanoEngineering of Microporous Membranes for Energy Storage. 1/11/2019-31/10/2024, €1.5M. https://www.imperial.ac.uk/news/192590/imperial-academics-11-million-erc-funding/
5. **CoI on EPSRC Programme Grant.** Synthesis of high selectivity membrane materials. 1/11/2021-31/10/2026. £9M in total, £900k for my group.
6. **CoI on EPSRC grant.** Anion exchange membrane water electrolysis for low-cost green hydrogen production

(AEM-H2). 1/9/2022 – 31/8/2023. £249,433.

7. **CoI on EPSRC ICASE Studentship.** Computational Design of Polymer Membranes for Energy Conversion and Storage (PhD studentship), 10/2020-30/9/2024, £87k.
8. **PI on Toyota Motor Europe.** Proton-exchange membranes for high temperature fuel cells. 12/2020-11/2021. €120k
9. **PI on EPSRC PhD studentship.** Improving performance of Redox Flow Batteries and Fuel cells for grid scale energy storage. 1/10/2019-30/6/2023. £87k.
10. **PI on EPSRC ICASE Studentship.** Nanoporous polymer membranes for Sensor Technology (PhD studentship). 9/2021-8/2025. £87k
11. **PI on BP-ICAM project.** Ion exchange membranes for energy conversion and storage. 10/2019-9/2023. £111k
12. **PI on Seed-funding,** EPSRC SUPERGEN Energy Storage Hub and CAM-IESCentre of Advanced Materials for Integrated Energy Systems (CAM-IES). Feasibility Study of Ion-Selective Microporous Polymer Membranes for Organic Redox Flow Batteries. 2017-2018. £99,980.
13. **PI on EPSRC IMSE seed funding.** Advanced Ionic-Selective Membranes in Aqueous Redox Flow Batteries for Energy Storage Applications. 2016-2017. £25k.
14. **PI on Imperial College Research Fellowship.** Design and Fabrication of Molecularly Defined Functional Materials. 2014-2017. £250k.

**Selected Fellowships and Awards**

2023 **Royal Society of Chemistry Materials Chemistry Horizon Prize**: Stephanie L Kwolek Prize. For *the development of ion-conducting polymers of intrinsic microporosity and applications as next-generation membranes in redox flow batteries for grid-scale energy storage*.
Link on RSC website: https://www.rsc.org/prizes-funding/prizes/2023-winners/microporous-membranes-team/

2019 **ERC Starting Grant Award (€1.5M).** Among 400 *awardees in all disciplines across the Europe. The ERC Starting grants are for researchers with 2-7 years of experience since the completion of their PhD, a scientific track record showing great promise and an excellent research proposal.*

2016 **IChemE Early Career Award - Nicklin Medal** for "*outstanding contribution to developing the next generation of microporous membrane materials, which can be used in energy conversion and storage*". The Nicklin Medal is an early career award to recognise talented chemical engineering researchers who have produced **international quality research outputs**.

2014 – 2016 **Imperial College Junior Research Fellowship** (*Independent research fellowship through open competition, the only award in Department of Chemical Engineering, among 20 awardees in all departments at Imperial College*)

2012 Best Oral Presentation Award at Euromembrane Conference, London.

2009-2013 Full Scholarship for PhD Study at Cambridge University, China Scholarship Council.

**Supervision of Graduate Students And Postdoctoral Fellows**

The team consists of two Postdocs, 9 PhD students, 3 Master Students, and several undergraduate students.

1. *Anqi Wang. Completed PhD in August 2021, PDRA (2021-2023), Design and synthesis of ion exchange membranes. Postdoctoral Research Associate on ERC Grant and EPSRC Programme Grant. RSC Energy sector PhD thesis prize. 2023 PMSE Future Faculty Honoree; Imperial College Department of Chemical Engineering Julia Higgins Centenary Prize for Best PhD thesis. 2020 Best Oral Presentation Award at 12th International Congress on Membranes & Membrane Processes.*
2. *Rui Tan. Completed PhD in August 2021, PDRA (2021-2023), Development of redox flow battery and solid-state batteries. Postdoctoral Research Associate on ERC Grant. Imperial College Department of Chemical Engineering PhD thesis Prize: 2021 Townend Prize, which is awarded for outstanding original research or critical analysis in any area of energy engineering. Currently: Assistant Professor at Warwick University.*
3. *Toby Wong. PhD student (2019-2023). Postdoc Research Associate (2023-2024). Ion exchange membranes for energy conversion and storage. PhD viva, 28 November 2023.*
4. *Chunchun Ye - Visiting PhD student (2017-2021). Synthesis of polymer membranes for flow batteries. Supervised by Prof Neil McKeown at University of Edinburgh. Completed PhD. Bronze medal for STEM for Britain Awards 2023.*
5. *Michael High. PhD student (2018-2023), Preparation of oxygen storage materials for chemical looping processes, co-supervised by Prof. Paul Fennell and Dr Kyra L. Sedransk Campbell (2018-2023). Completed*

*PhD.*

6. *Luke Petit. PhD student (2019-2023). Membrane Technology for Electrochemical energy conversion and storage. PhD viva, 13 November 2023.*
7. *Zhiyu Fan. PhD student (2019-2023). Synthesis and manufacturing of microporous membranes for energy and environmental applications.*
8. *Dezhi Liu. PhD student (2019-2023). Design and synthesis of microporous polymer membranes for molecular separations, co-supervised with Prof. Andrew Livingston.*
9. *Charlotte Breakwell. PhD student (2020-). Computational modelling of ion exchange membranes. Co-supervised with Dr Kim Jelfs, Prof. Anthony Kucernak.*
10. *Sunshine Iguodala - PhD student (2021-present) synthesis of polymer membranes for sensor applications. Co-supervisor: Prof Kim Jelfs*
11. *Yijie Yang (2022- present). Data-driven design and modeling of membranes Co-supervisor: Prof Kim Jelfs*
12. *Naiqi Meng (2022- present). Ion exchange membranes for fuel cells and electrolyzers*
13. *Masahiro Hara (2022-present). Metal-organic frameworks and mixed matrix membranes. Co-supervisor: Prof Jason Hallett*
14. *Dingchang Yang (2023-present). Electrodialysis membranes and processes for plastics recycling. Co-supervisor: Prof Magda Titirici*

Since 2014, I have supervised 50+ MEng and MSc students who are now working in global chemical and energy companies including BASF, Evonik, Schlumberger, SinoPec, and PhD study at EPFL and Imperial.

**Undergraduate Teaching Activities**

| | |
|---|---|
| 2018- | Lecturer – Membrane Science and Membrane Separation Processes, 30 hours lectures to undergraduate and postgraduate students, Imperial College London |
| 2017– | Lecturer – Final year design project, Imperial College London, UK |
| 2017– 2019 | Lecturer – $CO_2$ capture pilot plant, Imperial College London, UK |
| 2016–2017 | Teaching assistant – Physical Chemistry, Imperial College London, UK |
| 2015 – 2016 | Teaching assistant– Thermodynamics, Imperial College London, UK |
| 2016– | Supervisor of final year undergraduate research projects. |
| 2014–2016 | Daily supervisor of undergraduate research projects, |
| 2017–2018 | Supervisor of one link project between Imperial College and Shell (Amsterdam) on ion-exchange membranes for $CO_2$ capture process. |
| 2011 | Laboratory demonstrator, Cavendish Laboratory |
| 2011- 2012 | Supervisor for visiting master students from University of Paris VII |

**Institutional Responsibilities**

| | |
|---|---|
| 2016 – | Faculty member, Imperial College London, UK |
| 2016 – | Graduate Student Advisor, Imperial College London, UK |
| 2016 – | Tutees for undergraduate students, Imperial College London, UK |
| 2016 – | Organizer of the Barrer Centre Seminar, Imperial College London, UK |
| 2015 – | Member of Analytical Lab Committee; Imperial College London, UK |

**Reviewing Activities**

| | |
|---|---|
| 2021- | **Full Member of EPSRC Peer Review College**, Recognition of significant contribution to EPSRC Peer Review achieved a ranking in the top 4% of College members for participating in peer review in the last academic year (2020/21). |
| 2019- | Research grant reviewer for UK Engineering and Physical Science Research Council, ERC grant, ERC Advanced Grant, ERC Starting Grant, and ERC Consolidator Grant, Austrian Research Promotion Agency (FFG), Nanyang Technological University (NTU), King Abdullah University of Science and Technology (KAUST). |
| 2010 – | Peer reviewer for Science, Nature Materials, Nature Energy, Nature Sustainability, Nature Communications, PNAS, ACS Central Science, JACS, Advanced Materials, Advanced |

Functional Materials, Energy & Environmental Science, Chemistry of Materials, Chemical Communications, Cell Reports Physical Science, Journal of Membrane Science, Chemical Engineering Journal, Applied Energy, Energy and Fuels, Fuel, Industrial Chemistry and Engineering Research.

**Memberships of scientific societies**

2016 – Principal Investigator, Research Centre "*Barrer Centre*" at Imperial College
2016 – Associated Member, Institute of Molecular Science and Engineering, Imperial College
2016 – Affiliate member, Grantham Institute, Imperial College London
2016 – Member, Research Network 'Energy Futures Lab', Imperial College London
2018– Associated member, The Composite Centre, Imperial College London
2012– Member of Royal Society of Chemistry, ACS, European Membrane Society, AIChE.

**Patents**

Q. Song and E. Sivaniah. Crosslinked polymer, method for producing the same, molecular sieve composition and material separation membranes. Filed via Cambridge Enterprise, transferred to Kyoto University. JST application number: S2014-0570-N0. PCT application No: PCT/JP2015/056582. International Publication Number: WO/2015/129925A1. US patent granted US10076728B2, 18th September 2018.

**Recent Publications**

I have authored and co-authored 60+ papers in peer-reviewed journals, including ***Nature, Nature Materials, Nature Energy, Nature Communications***, ***JACS, Angew Chem Int Ed., Advanced Materials***, ***Energy & Environmental Science, Journal of Materials Chemistry A***, and papers in chemical engineering fields. Several papers are under review or in preparation for submission (not listed).

**Selected publications**

1. Rui Tan, Anqi Wang, Chunchun Ye, Jiaxi Li, Dezhi Liu, Barbara Primera Darwich, Luke Petit, Zhiyu Fan, Toby Wong, Alberto Alvarez-Fernandez, Mate Furedi, Stefan Guldin, Charlotte E. Breakwell, Peter A. A. Klusener, Anthony R. Kucernak, Kim E. Jelfs, Neil B. McKeown, **Qilei Song***. *Thin Film Composite Membranes with Regulated Crossover and Water Migration for Long-Life Aqueous Redox Flow Batteries*. ***Advanced Science***, 2023. 10, 2206888.
2. Anqi Wang, Rui Tan, Dezhi Liu, Jiaxin Lu, Xiaochu Wei, Alberto Alvarez-Fernandez, Chunchun Ye, Charlotte Breakwell, Stefan Guldin, Anthony R. Kucernak, Kim E. Jelfs, Nigel P. Brandon, Neil B. McKeown and **Qilei Song***. *Ion-selective Microporous Polymer Membranes with Hydrogen-bond and Salt-bridge Networks for Aqueous Organic Redox Flow Batteries*. ***Advanced Materials***, 2023, 2210098.
3. Michael High, Clemens F. Patzschke, Liya Zheng, Dewang Zeng, Oriol Gavalda-Diaz, Nan Ding, Ka Ho Horace Chien, Zili Zhang, George E. Wilson, Andrey V. Berenov, Stephen J. Skinner, Kyra L. Sedransk Campbell, Rui Xiao*, Paul S. Fennell* & **Qilei Song***. *Precursor engineering of hydrotalcite-derived redox sorbents for reversible and stable thermochemical oxygen storage*. ***Nature Communications*** 13, 5109 (2022). https://www.imperial.ac.uk/news/239513/better-metal-oxides-boost-green-credentials/
4. Anqi Wang, Rui Tan, Charlotte Breakwell, Xiaochu Wei, Zhiyu Fan, Chunchun Ye, Richard Malpass-Evans, Tao Liu, Martijn A. Zwijnenburg, Kim E. Jelfs, Neil B. McKeown*, Jun Chen, and **Qilei Song***. Solution-Processable Redox-Active Polymers of Intrinsic Microporosity for Electrochemical Energy Storage. ***Journal of the American Chemical Society*** 2022 144 (37), 17198-17208. https://www.imperial.ac.uk/news/240893/new-polymer-based-batteries-could-offer-promise/
5. C. Ye, R. Tan, A. Wang, J. Chen, B. Comesaña Gándara, C. Breakwell, A. Alvarez-Fernandez, Z. Fan, J. Weng, C. G. Bezzu, S. Guldin, N. P. Brandon, A. R. Kucernak, K. E. Jelfs, N. B. McKeown*, **Q. Song***, *Long-Life Aqueous Organic Redox Flow Batteries Enabled by Amidoxime-Functionalized Ion-Selective Polymer Membranes*. ***Angew. Chem. Int. Ed.*** **2022**, *61*, e202207580; *Angew. Chem.* **2022**, *134*, e202207580.
6. Chunchun Ye, Anqi Wang, Charlotte Breakwell, Rui Tan, C. Grazia Bezzu, Elwin Hunter-Sellars, Daryl R. Williams, Nigel P. Brandon, Peter A. A. Klusener, Anthony R. Kucernak, Kim E. Jelfs, Neil B. McKeown* & **Qilei Song***. *Development of efficient aqueous organic redox flow batteries using ion-sieving sulfonated polymer membranes*. ***Nature Communications***, 13, Article number: 3184 (2022).
7. Yuhua Xia, Mengzheng Ouyang, Vladimir Yufit, Rui Tan, Anna Regoutz, Anqi Wang, Wenjie Mao, Barun Chakrabarti, Ashkan Kavei, **Qilei Song**, Anthony R. Kucernak & Nigel P. Brandon. *A cost-effective alkaline*

*polysulfide-air redox flow battery enabled by a dual-membrane cell architecture*. ***Nature Communications***, 13, 2388, 2022.

8. Zhizhang Yuan, Lixin Liang, Qing Dai, Tianyu Li, **Qilei Song**, Huamin Zhang, Guangjin Hou, and Xianfeng Li*, *Low-Cost Hydrocarbon Membrane Enables Commercial-Scale Alkaline-Based Flow Batteries for Long-Duration Energy Storage*. ***Joule***, 6, 884-905, 2022.
9. Katherine Mizrahi Rodriguez, Wan-Ni Wu, Taliehsadat Alebrahim, Yiming Cao, Benny D Freeman, Daniel Harrigan, Mayank Jhalaria, Adam Kratochvil, Sanat Kumar, Won Hee Lee, Young Moo Lee, Haiqing Lin, Julian M Richardson, **Qilei Song**, Benjamin Sundell, Raymond Thür, Ivo Vankelecom, Anqi Wang, Lina Wang, Catherine Wiscount, Zachary P Smith. *Multi-lab study on the pure-gas permeation of commercial polysulfone (PSf) membranes: Measurement standards and best practices*. **Journal of Membrane Science.** 659, 2022, 120746**.**
10. Evan Wenbo Zhao, Tao Liu, Erlendur Jónsson, Jeongjae Lee, Israel Temprano, Rajesh B. Jethwa, Anqi Wang, Holly Smith, Javier Carretero-González, **Qilei Song** & Clare P. Grey*. *In situ NMR metrology reveals reaction mechanisms in redox flow batteries*. ***Nature*** *579, 224–228(2020).*
11. Peipei Zuo, Yuanyuan Li, Anqi Wang, Rui Tan, Yahua Liu, Xian Liang, Fangmeng Sheng, Gonggeng Tang, Liang Ge, Liang Wu, Qilei Song*, Neil B McKeown*, Zhengjin Yang*, Tongwen Xu*. *Sulfonated microporous polymer membranes with fast and selective ion transport for electrochemical energy conversion and storage*. ***Angew. Chem. Int. Ed.*****, 2020**, *59*, 9564.
12. Rui Tan, Anqi Wang, Richard Malpass-Evans, Rhodri Williams, Evan Wenbo Zhao, Tao Liu, Chunchun Ye, Xiaoqun Zhou, Barbara Primera Darwich, Zhiyu Fan, Lukas Turcani, Edward Jackson, Linjiang Chen, Samantha Y. Chong, Tao Li, Kim E. Jelfs, Andrew I. Cooper, Nigel P. Brandon, Clare P. Grey, Neil B. McKeown*, and **Qilei Song***. *Hydrophilic microporous membranes for selective ion separation and flow-battery energy storage*. ***Nature Materials***, 19, 195–202(2020).
    https://www.imperial.ac.uk/news/194186/new-membrane-technology-boost-water-purification/
13. S. Jiang, **Q. Song***, A. Massey, S. Y. Chong, L. Chen, S. Sun, T. Hasell, R. Raval, E. Sivaniah, A. K. Cheetham, A. I. Cooper, *Oriented Two-Dimensional Porous Organic Cage Crystals*, ***Angew. Chem. Int. Ed.***, **2017**, 56, 9391–9395.
14. B. Ghale, K. Sakurai, Y. Kinoshita, K. Wakimoto, A. Pournaghshband Isfahani, **Q. Song**, K. Doitomi, S. Furukawa, H. Hirao, H. Kusuda, S. Kitagawa, E. Sivaniah, *Enhanced selectivity in mixed matrix membranes for $CO_2$ capture through efficient dispersion of amine-functionalised MOF nanoparticles*, ***Nature Energy***. **2017**, 2, Article number: 17086.
15. M. Jimenez-Solomon+, **Q. Song+**, K. Jelfs, M. Munoz-Ibanez, A.G. Livingston. *Polymer nanofilms with enhanced microporosity by interfacial polymerization*. ***Nature Materials***. 2016. 15, 760-767. (+Contributed equally).
16. **Q. Song**, S. Jiang, T. Hasell, M. Liu, S. Sun, A.K. Cheetham, E. Sivaniah, A.I. Cooper. *Porous Organic Cage Thin Films and Molecular-Sieving Membranes*. ***Advanced Materials***. 2016, 13, 2629-2637.
17. **Q. Song**, S. Cao, R.H. Pritchard, B. Ghalei, S.A. Al-Muhtaseb, E.M. Terentjev, A.K. Cheetham, and E. Sivaniah. *Controlled thermal oxidative crosslinking of polymers of intrinsic microporosity towards tunable molecular sieve membranes*. ***Nature Communications***, 2014, 5, article number 4813. Full text, Press Release by Cambridge University.
18. **Q. Song**, S. Cao, P. Zavala-Rivera, L.P. Lu, W. Li, Y. Ji, S.A. Al-Muhtaseb, A.K. Cheetham and E. Sivaniah. *Photo-oxidative enhancement of polymeric molecular sieve membranes.* ***Nature Communications***, 2013, 4, article number 1918. Link; Press release by Cambridge University
19. **Q. Song**, W. Liu, C. D. Bohn, R. N. Harper, E. Sivaniah, S. A. Scott and J. S. Dennis. *A high performance oxygen storage material for chemical looping processes with $CO_2$ capture*, ***Energy & Environmental Science***, 2013, 6, 288-298.
20. **Q. Song**, S. K. Nataraj, M. V. Roussenova, J. C. Tan, D. J. Hughes, W. Li, P. Bourgoin, M. A. Alam, A. K. Cheetham, S. A. Al-Muhtaseb and E. Sivaniah. *Zeolitic imidazolate framework (ZIF-8) based polymer nanocomposite membranes for gas separation*, ***Energy & Environmental Science***, 2012, 5, 8359-8369.