DALIAN INSTITUTE OF CHEMICAL PHYSICS,
CHINESE ACADEMY OF SCIENCES

Wenping Li

PERSONAL INFORMATION

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EDUCATION

- Sep. 2012-Sep. 2018 — Ph.D. in Physical Chemistry
  State Key Laboratory of Catalysis, Dalian Institute of Chemical Physics(DICP), Chinese Academy of Sciences, China
  Supervisor: Prof. Weishen Yang, Prof. Xuefeng Zhu
  Thesis title: Novel reaction-separation coupling processes in oxygen-permeable membrane reactors
- Sep. 2008-Jun. 2012 — B.S. in Applied Chemistry
  Beijing University of Chemical Technology (BUCT), Beijing, China
  Supervisor: Prof. Yufei Song
  Thesis title: Preparation and characterization of polyoxometalates-based photosensitive hybrid materials

EMPLOYMENT

- Sep. 2019-Mar. 2020 — Postdoctoral fellow in University of Alberta under Prof. Jingli Luo's supervision
- Sep. 2018-Aug. 2019 — Temporary member without formal position (Trainee) in DICP

RESEARCH INTERESTS

- Catalytic membrane reactor
- Membrane for gas separation (such as O_2, N_2, H_2, CO_2, etc.)
- Solid state electrochemical cell
- Chemical looping for CO_2 capture and carbonaceous fuel conversion

PROFESSIONAL & TECHNICAL SKILLS

- Strong Catalysis, Chemical Engineering and Chemistry background (Ph.D. and B.S.).
- 6 years' research experiences in construction of membrane reactors for novel reaction-separation coupling processes.
- Expertise in synthesis of mixed-conducting materials and catalysts, fabrication of membranes with different structures and sealing methods for high-temperature reactor at reducing atmosphere with water vapor.
- Expertise in several characterization techniques, including XRD, SEM, EDS, UV-Vis, TG, and GC.
- Proficient use of Microsoft Office programs, OriginLab, ChemDraw, Photoshop, HSC, etc.

RESEARCH EXPERIENCE

- **Construction reaction-separation coupling strategy in membrane reactor for coproduction of two kinds of syngases**

During 2013-2017, I devoted to develop the coupling strategy of coproduction of ammonia synthesis gas (ASG, H_2/N_2 = 3) and liquid fuel synthesis gas (LFSG, H_2/CO = 2) from water, air and methane in one oxygen-permeable membrane reactor, which was proposed by our group and aimed to combine industrial six-steps for ASG production and three-steps for LFSG production into one step. The preparation of membranes, the design of membrane reactor, the bulid of the test equipment, the sealing of the membrane and the adjustment of test condition are the key points. In this work, I successfully verified this innovative concept in a perovskite membrane reactor with excellent performance, i. e., 18.8 mL cm^{-2} min^{-1} ASG production rate accompanied with 45.6 mL cm^{-2} min^{-1} LFSG production rate. A 63.3% energy saving can be achieved compared to traditional industrial processes. For further enhancement of the performance and the stability of membrane material of the membrane reactor, an asymmetric dual-phase oxygen-permeable membrane was prepared for ASG and LFSG coproduction. As the structure of the membrane reactor has an extremely high requirement on the evenness of the membrane, I devoted much effort to adjust the evenness of the asymmetric membrane. The acquired ASG and LFSG production rates were obviously prior to that of the perovskite membrane reactor and the stability of membrane materials was also improved apparently. Compared with industrial processes for ASG and LFSG coproduction, the membrane reactor process has many advantages: high process intensification, huge energy saving, high safety, environmental friendliness and clean ASG product. This membrane reactor process offers a new opportunity for the reform of natural gas chemical industry. (Published in *Angew. Chem. Int. Ed.*, 2016, 55, 8566-8570.; *Int. J. Hydrogen Energy*, 2019, 44, 4218-4227.)

- **Construction reaction-separation coupling strategy in membrane reactor for hydrogen separation to acquire high-purity or ultra-high-purity hydrogen**

During 2015-2018, I focused on the application of oxygen-permeable membrane reactor in hydrogen separation. In this work, the concept of hydrogen separation in oxygen-permeable membrane was first definitely proposed and successfully verified. A hydrogen separation rate high up to 16.3 mL cm^{-2} min^{-1} was achieved at 900 ºC with separation factor up to >10,000, which is 2-3 orders higher than the proton conducting membranes, and comparable to Pd based metallic membranes. Besides, no performance degradation was observed in a long-term operation with the feeding gas containing 200 ppm H_2S. Syngas with various H_2/CO ratios as low-purity hydrogen was also fed to membrane reactor to simulate practical situation, and a hydrogen separation rate as high as 13.5 mL cm^{-2} min^{-1} was recorded at 950 ºC. Moreover, the effects of membrane thickness and structure on the hydrogen separation performance of oxygen-permeable membrane reactors were also studied to explore their inner relationship. This type of membrane reactor can be used to produce high-purity or ultra-high-purity hydrogen for fuel cells, semiconductor manufacturing, photovoltaic cells production, etc. The experiments presented in this work indicate that this new method has a bright future for hydrogen separation. (Published in *Energy Environ. Sci.,* 2017, 10, 101-106.; *AIChE J.*, 2017, 63, 1278-1286.; *J. Membr. Sci.*, 2019, 573, 370-376.)

- **Development new dual-phase membranes materials as well as study oxygen permeation mechanism**

During 2013-2019, I also developed new dual-phase membrane materials and studied the related oxygen permeation mechanism. The effect of Bi doping into dual-phase oxygen-permeable membrane materials was investigated systematically for the first time. This work discloses that, unlike Bi doping would increase the permeability of perovskite membranes and ionic conductivity of ceria, Bi doping into dual-phase membranes has complex effect on the performance, which depends on the elemental composition of the dual-phase membrane materials. Besides, for a deep understanding on the oxygen exchange kinetics and diffusion kinetics of the oxygen-permeable membrane, oxygen permeation model was adopted to acquire the oxygen permeation resistances and kinetic parameters of perovskite and dual-phase membranes. (Published in *J. Membr. Sci.*, 2019, 579, 342-350.; *J. Membr. Sci.*, 2019, 573, 628-638.; *Sep. Purif. Technol.*, 2020, 235, 116224.)

- **Improving the cathode performance for CO_2 electrolysis in SOEC by F doping**

During my postdoc work at University of Alberta, I was working on adopting F doping strategy to improve the cathode performance surrounding electroreduction of CO_2 in solid oxide electrolysis cell (SOEC). By F doping into cathode materials, the high electronegativity (4.0) of fluorine weakens the A-O and B-O bond, and electrostatic repulsion between $F_{\dot{O}}$ and $V_{\ddot{O}}$ promotes the mobility of $V_{\ddot{O}}$, which brings the enhancement of the concentration of $V_{\ddot{O}}$ and improvement of electrical conductivity.

PUBLICATIONS

1. **Wenping Li**, Zhongwei Cao, Lili Cai, Lixiao Zhang, Xuefeng Zhu,* Weishen Yang,* H_2S-tolerant oxygen-permeable ceramic membranes for hydrogen separation with a performance comparable to those of palladium-based membranes, *Energy Environ. Sci.*, 2017, 10, 101-106.
2. **Wenping Li**, Xuefeng Zhu,* Shuguang Chen, Weishen Yang,* Integration of nine steps into one membrane reactor to produce synthesis gases for ammonia and liquid fuel, *Angew. Chem. Int. Ed.*, 2016, 55, 8566-8570.
3. **Wenping Li**, Zhongwei Cao, Xuefeng Zhu,* Weishen Yang,* High-rate hydrogen separation using an MIEC oxygen permeable membrane reactor, *AIChE J.*, 2017, 63, 1278-1286.
4. **Wenping Li**, Zhongwei Cao, Xuefeng Zhu,* Weishen Yang,* Effects of membrane thickness and structural type on the hydrogen separation performance of oxygen-permeable membrane reactors, *J. Membr. Sci.*, 2019, 573, 370-376.
5. **Wenping Li**, Zhongwei Cao, Hongbo Li, Xuefeng Zhu,* Weishen Yang, Asymmetric dual-phase MIEC membrane reactor for energy-efficient coproduction of two kinds of synthesis gases, *Int. J. Hydrogen Energy*, 2019, 44, 4218-4227.
6. **Wenping Li**, Xuefeng Zhu,* Zhongwei Cao, Weiping Wang, Weishen Yang,* Mixed ionic-electronic conducting (MIEC) membranes for hydrogen production from water splitting, *Int. J. Hydrogen Energy*, 2015, 40, 3452-3461.
7. Claudia Li,[#] **Wenping Li**,[#] Jiuan Jing Chew, Shaomin Liu, Xuefeng Zhu,* Jaka Sunarso,* Rate determining step in SDC-SSAF dual-phase oxygen permeation membrane, *J. Membr. Sci.*, 2019, 573, 628-638. ([#]co-first author)
8. Song Huang,[#] **Wenping Li**,[#] Zhongwei Cao, Hongbo Li, Hongchao Ma,* Xuefeng Zhu,* Weishen Yang, Effect of Bi doping on the performance of dual-phase oxygen permeable membranes, *J.*

Membr. Sci., 2019, 579, 342-350. ([#]co-first author)

9. Claudia Li,[#] **Wenping Li**,[#] Jiuan Jing Chew, Shaomin Liu, Xuefeng Zhu,* Jaka Sunarso,* Oxygen permeation through single-phase perovskite membrane: Modeling study and comparison with the dual-phase membrane, *Sep. Purif. Technol.*, 2020, 235, 116224. ([#]co-first author)

10. **Wenping Li**, Jing-Li Luo*, High-temperature electrochemical devices based on dense ceramic membranes for CO_2 conversion and utilization, *Electrochem. Energy Rev.*, 2020, under review.

11. Yue Zhu, **Wenping Li**, Lili Cai, Xuefeng Zhu,* Weishen Yang,* Universally applicable kinetic model for mixed ionic-electronic conducting membranes, *Chem. Eng. Sci.*, 2020, 215, 115455.

12. Yue Zhu, **Wenping Li**, Yan Liu, Xuefeng Zhu,* Weishen Yang,* Selection of oxygen permeation models for different mixed ionic-electronic conducting membranes, *AIChE J.*, 2017, 63, 4043-4053.

13. Lili Cai, **Wenping Li**, Zhongwei Cao, Xuefeng Zhu,* Weishen Yang,* Improving oxygen permeation of MIEC membrane reactor by enhancing the electronic conductivity under intermediate-low oxygen partial pressures, *J. Membr. Sci.*, 2016, 520, 607-615.

14. Yue Zhu, Lili Cai, **Wenping Li**, Zhongwei Cao, Hongbo Li, Heqing Jiang, Xuefeng Zhu,* Weishen Yang,* A permeation model study of oxygen transport kinetics of $Ba_xSr_{1-x}Co_{0.8}Fe_{0.2}O_{3-\delta}$, *AIChE J.*, 2020, 66, e16291.

15. Lixiao Zhang, Shiqing Hu, **Wenping Li**, Peng Zhang, Zhongwei Cao, Xuefeng Zhu,* Weishen Yang, CO_2 electroreduction enhanced by transitional layer at cathode/electrolyte interface, *J. Power Sources*, 2020, 451, 227743.

16. Lixiao Zhang, Shiqing Hu, **Wenping Li**, Zhongwei Cao, Huanying Liu, Xuefeng Zhu,* Weishen Yang, Nano-CeO_2-modified cathodes for direct electrochemical CO_2 reduction in solid oxide electrolysis cells, *ACS Sustainable Chem. Eng.*, 2019, 7, 9629-9636.

17. Zhongwei Cao, Xuefeng Zhu,* **Wenping Li**, Bing Xu, Lina Yang,* Weishen Yang, Asymmetric dual-phase membranes prepared via tape-casting and co-lamination for oxygen permeation, *Mater. Lett.*, 2015, 147, 88-91.

18. Yan Liu, Xuefeng Zhu,* Mingrui Li, **Wenping Li**, Weishen Yang,* Degradation and stabilization of perovskite membranes containing silicon impurity at low temperature, *J. Membr. Sci.*, 2015, 492, 173-180.

19. Huanying Liu, Kaiyue Zhu, Yan Liu, **Wenping Li**, Lili Cai, Xuefeng Zhu,* Mojie Cheng, Weishen Yang,* Structure and electrochemical properties of cobalt-free perovskite cathode materials for intermediate-temperature solid oxide fuel cells, *Electrochim. Acta*, 2018, 279, 224-230.

20. Shiqing Hu, Lixiao Zhang, Huanying Liu, **Wenping Li**, Zhongwei Cao, Lili Cai, Yue Zhu, Xuefeng Zhu,* Weishen Yang, Detrimental phase evolution triggered by Ni in perovskite-type cathodes for CO_2 electroreduction, *J. Energy Chem.*, 2019, 36, 87–94.

PRESENTATIONS

1. **Wenping Li**, Xuefeng Zhu, Weishen Yang, Development of a new oxygen permeation model and experimental investigations, Oral presentation, The 17th National Conference on Solid State Ionics and International Forum on New Energy Material and Technology, August 2-6, 2014, Baotou, China. (Excellent paper award)
2. Xuefeng Zhu, **Wenping Li**, Shuguang Chen, Weishen Yang, Simultaneous producing two types of syngases in one membrane reactor, Oral presentation, The 9th Sino-US Joint Conference of Chemical Engineering, October 15-19, 2017, Beijing, China. (Wenping Li was the reporter)
3. **Wenping Li**, Xuefeng Zhu, Weishen Yang, Hydrogen separation using MIEC oxygen-permeable membranes, Poster presentation, Global Chinese Chemical Engineering Symposium, July 18-21, 2017, Hangzhou, China.
4. **Wenping Li**, Xuefeng Zhu, Weishen Yang, Co-producing ammonia and liquid-fuel synthesis gases in one mixed conducting membrane reactor, Poster presentation, The 18th National Conference on Solid State Ionics and International Forum on Electrochemical Energy Storage Technologies, November 3-8, 2016, Guilin, China.

HONORS & AWARDS

1. 2018 Excellent Award of the President of the Chinese Academy of Sciences
2. 2018 Excellent Graduates of University of Chinese Academy of Sciences
3. 2017 National Scholarship for Postgraduate
4. 2017 First Prize of Postgraduate Scholarship of Bohai Chemical Industry
5. 2017 Zhu Li Yuehua Outstanding Doctoral Scholarship of the Chinese Academy of Sciences
6. 2017 Pacemaker to Merit Student of the University of Chinese Academy of Sciences