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Education

Ph.D. in Materials Science and Engineering

(Advisor: Prof. Husam N. Alshareef)

King Abdullah University of Science & Technology (Kaust), 2016/08 ~ 2020/12

M. Phil in Materials Science and Engineering

(Advisor: Prof. Haibo Jin and Prof. Yongjie Zhao)

Beijing Institute of Technology (BIT), 2013/9 ~ 2016/3

Bachelor in Materials Science and Engineering

Hubei University of Technology (HBUT), 2008/09 ~ 2012/07

Working experience

Research consultant (Postdoc Level)

(Advisor: Prof. Husam N. Alshareef)

King Abdullah University of Science & Technology (Kaust), 2020/12 ~ 2021/03

Postdoc Fellow

(Advisor: Prof. Husam N. Alshareef)

King Abdullah University of Science & Technology (Kaust), 2021/04 ~ Current

Research Experience

1. MXene in Electronics (MXetronics)

- **Description:** We successfully fabricated large-area transistor circuits using solution-processed $Ti_3C_2T_x$ MXene as source/drain and gate contact electrodes, wafer-scale MoS_2 film as channel, and ultrathin HfO_2/Al_2O_3 layer of about 8 nm as the dielectric layer. The high yield and performance uniformity of the device array indicate great potential of the $Ti_3C_2T_x$ MXene in large-area ultrathin 2D electronics.

2. MXene-Derived MOF in Electronics.

- **Description:** We successfully demonstrated that MXene-derived MOF film is high-quality and standard cleanroom lithography (UV and E-beam) processable. Also, we

are the first to demonstrate the MOF film as the solid electrolyte in the ionic-gate micro-transistors. This project opens a door for MXene or MXene-derived MOF application in iontronics.

3. Lattice Orientation Heredity in the transformation of 2D Epitaxial Films

- **Description:** The process using lattice orientation heredity is a unique but universal strategy for preparing many non-oxide layered and non-layered highly-oriented films. Different from direct epitaxial deposition, it is developed based on the heredity phenomena in material science. It provides new possibilities for GaN related technology on disordered substrates, also signifies a unique angle for large-area 2D MoS₂ film high-end scalable application.

4. Two-Dimensional MoS₂ films Growth at the Wafer Scale

- **Description:** The wafer-scale mono-oriented MoS₂ film was obtained from the epitaxial precursor MoO₂ film sulfurization. We discovered that the crystal quality of the precursor has a critical effect on the crystallinity of final product 2D films. We use pulsed laser deposition (PLD) to grow the epitaxial MoO₂ film and chemical vapor deposition (CVD) system to do the sulfurization process. Thus, we obtained the best-quality MoS₂ film with the highest electronic performance compare with that from sulfurization of reported low-crystallinity precursor films.

5. Self-Assembly and Catalytic Performance Research of Magnetic Metallic Oxide Super Crystal, 2014/07 ~ 2015/12

- **Description:** Solvothermal synthesis of different metallic oxide particles with various morphologies, such as Co microplates and micro-chains, Co₃O₄ flowers, Fe₂O₃ flowers and nanocubics, NiO Chestnut shell nanostructures. Investigating their magnetic properties, catalytic performance in the thermal decomposition of ammonium perchlorate and battery negative electrode performance.

Reviewer Experience

- As an invited reviewer for **8 papers** in several journals such as **Front. Mater., Carbon, Applied Surface Science, Mater. Chem. Phys.,** and **ACS Crystal Growth & Design**

Teaching Experience

- **Co-supervision of Ph.D. student** (2020/08-current), Mr. Tianchao Guo
- **Co-supervision of Master student** (2020/08-current), Mr. Rajeh Alsaadi
- **Co-supervision of Master student** (2019/06-2019/08), Mr. Rajeh Alsaadi (currently an undergraduate student of Penn state)
- **Co-supervision of an intern student** (2019/06-2019/08), Mr. Rajeh Alsaadi (currently an undergraduate student of Penn state)
- **Co-supervision of a visiting student** (2017/11-2018/01), Mr. Yorick Birkhölzer (currently a PhD student of University of Twente)

Industrial Experience

1. Assistant Engineer of Lithography Process and Equipment, 2013/1 ~ 2013/9

- Wuhan tianma microelectronics co., LTD, Wuhan, China
- Analyzing the defective products through test machines macro-micro optical

Inspections, circular dichroism (CD) and overlay measurement machines. Improving the overall yield of a thin-film transistor at the lithography process. Regular maintenance of lithography machines. Developing technological parameters of LCD products at the lithography process.

2. Assistant Engineer of Lithography Process, 2012/7 ~ 2012/11

- Shenchao photo-electronics co., LTD, Shenzhen, China
- Analyzing the defective products through test machines macro-micro optical Inspections, circular dichroism (CD) and overlay measurement machines. Improving the overall yield of the thin-film transistor at the lithography process.

Conferences

- **Xiangming Xu**, Wafer scale quasi single crystalline (SC) MoS₂ realized by epitaxial phase conversion. Poster presentation in International Symposium “Low Dimensional Materials for Optoelectronics” Shenzhen, China, October 25 -28, 2018 (*presentation*)
- **Xiangming Xu**, Wafer-Scale MoS₂ Films from Epitaxial Precursor with Tunable Thickness and Properties. Oral presentation in International Symposium on Flexible Organic Electronics 2019 (ISFOE19), Thessaloniki, Greece, July 1-4. (*oral, Young Researcher Award*)
- **Xiangming Xu**, Wafer scale single crystalline MoS₂ realized by epitaxial phase conversion. *Oral presentation* in Graphene 2020 online International Symposium, France, October 19-23, 2020.
- **Xiangming Xu**, Electronic Grade 2D films for Emerging Micro-Devices Applications. *Invited speaker* in 3th Global Webinar on Materials Science and Engineering, March 11-13, 2022
- **Xiangming Xu**, High-quality 2D films preparation methods for large-area integrated circuits. *Invited speaker* in Global Summit on Nanomaterials: Applications and Properties (NANOMAT22) in Dubai, UAE, March 23-25, 2022.

Awards and Honors

- Young Research Award (oral presentation) at the 12th International Symposium on Flexible Organic Electronics, ISFOE 2019, Thessaloniki, Greece, July 1-4, 2019
- Outstanding M. Phil. Dissertation of Beijing Institute of Technology, 2016
- Outstanding M. Phil Graduate of Beijing Institute of Technology, 2016
- National scholarship for graduate students, 2015
- Second Prize of Chemical skills Contest, 2009

Research Interest

- Developing high-quality 2D films or heterojunction (MXenes, 2D TMDs, MOF) for electronics.
- Design new electronic devices such as Fe-FET, EDLT and TFT based on our new film or heterojunction systems.

- Exploring the lattice orientation heredity phenomena during the thin film chemical transformation process, and the 2D film assisting GaN film growth.

Keywords: Epitaxy growth, phase conversion, 2D electronics, emerging electronics.

Highlights of Qualifications

- High-vacuum Pulsed Laser deposition (PLD) system maintenance and utilization.
- Chemical vapor deposition (CVD) growth system setup and utilization.
- Magnetron sputtering deposition (SnO, Au/Ti, SiO₂), e-beam evaporation (EBE) deposition (Au/Ti), atomic layer deposition (ALD) system (ZnO, HfO₂, Al₂O₃), Plasma enhanced chemical vapor deposition (PECVD) system (Si₃N₄), spin-coating (MOF film), spray coating (MXene film).
- 4-years cleanroom experience (lithographic mask design and writing, photolithography, wet etching, dry etching, microscopic probe-station, etc.).
- Materials characterization by SEM, AFM, TEM, Thin film-HR XRD, Raman spectroscopy
- The other skills (hydrothermal synthesise of nanocrystals with different morphologies, coin battery assembly and testing)

Publications

First or co-first author:

1. **Xiangming Xu**[§], Chenhui Zhang[§], Jun Yin[§], Jasmin Smajic, Mohammed Bahabri, Yongjiu Lei, Mohamed Nejib Hedhili, Mrinal K Hota, Lin Shi, Tianchao Guo, Jehad K. El-Demellawi, Mario Lanza, Pedro M. F. J. Costa, Osman M. Bakr, Omar F. Mohammed, Xixiang Zhang*, Husam N. Alshareef*, Anisotropic Superconductivity of Nb₂CT_x MXene Processed by Atomic Exchange. Submitted.
2. **Xiangming Xu**, Tianchao Guo, Husam N. Alshareef,* Status and Prospects of MXene-based Nanoelectronic Devices. *Matter*, 2023, 6, 800-837.
3. Chuanju Wang[§], **Xiangming Xu**[§], Shubham Tyagi, Paresh C. Rout, Udo Schwingenschlögl, Biplab Sarkar, Xinke Liu, Linfei Gao, Mohamed Nejib Hedhili, Husam N. Alshareef*, Xiaohang Li,* Ti₃C₂T_x MXene van der Waals Gate Contact for GaN High Electron Mobility Transistors, *Adv. Mater.* 2023, 35, 2211738. (§contributed equally)
4. Tianchao Guo[§], **Xiangming Xu**[§], Chen Liu, Yizhou Wang, Bin Fang, Hang Liu, Mrinal K. Hota, Xixiang Zhang, Husam N. Alshareef,* Large-Area Metal–Semiconductor Heterojunctions through MXene-Induced Two-Dimensional Surface Polarization. *ACS Nano* 2023, 17, 9, 8324–8332. (§contributed equally)
5. Yizhou Wang[§], **Xiangming Xu**[§], Gang Huang, Tianchao Guo, Zhengnan Tian, Rajeh Alsaadi, Yunpei Zhu, Husam N. Alshareef,* MoS₂-Mediated Epitaxial Plating of Zn Metal Anodes, *Advanced Materials*, 2022, 2208171. (§contributed equally)
6. **Xiangming Xu**, Tianchao Guo, Hyunho Kim, Mrinal K. Hota, Rajeh S. Alsaadi, Mario Lanza, Xixiang Zhang, Husam N. Alshareef*, Growth of Two-Dimensional Materials at the Wafer Scale, *Advanced Materials*, 2022, 2108258.
7. **Xiangming Xu**, Jasmin Smajic, Kuang-hui Li, Jung-Wook Min, Yongjiu Lei, Bambar Davaasuren, Xin He, Xixiang Zhang, Boon S. Ooi, Pedro M. F. J. Costa, Husam N. Alshareef*, Lattice Orientation Heredity in the Transformation of 2D Epitaxial Films, *Advanced Materials*, 2022, 34, 2105190.
8. **Xiangming Xu**[§], Tianchao Guo[§], Mrinal K Hota, Hyunho Kim, Dongxing Zheng, Chen Liu, Mohamed Nejib Hedhili, Rajeh S Alsaadi, Xixiang Zhang, Husam N Alshareef*,

- High-Yield $Ti_3C_2T_x$ MXene-MoS₂ Integrated Circuits, *Advanced Materials*, 2021, 2107370. (§contributed equally)
9. **Xiangming Xu**, Hao Wu, Xin He, Mrinal K. Hota, Zhixiong Liu, Sifei Zhuo, Hyunho Kim, Xixiang Zhang, Husam N. Alshareef, Iontronics Using V₂CT_x MXene-Derived Metal-Organic Framework Solid Electrolytes, *ACS Nano*, 2020, 14, 8, 9840–9847.
 10. **Xiangming Xu**, Chenhui Zhang, Mrinal K. Hota, Zhixiong Liu, Xixiang Zhang, Husam N. Alshareef, Enhanced Quality of Wafer-Scale MoS₂ Films by a Capping Layer Annealing Process, *Advanced Functional Materials*, 2019, 1908040.
 11. **Xiangming Xu**, Gobind Das, Xin He, Mohamed Nejjib Hedhili, Enzo Di Fabrizio, Xixiang Zhang, Husam N Alshareef, High - Performance Monolayer MoS₂ Films at the Wafer Scale by Two - Step Growth, *Advanced Functional Materials*, 2019, 29, 1901070. (*highlighted in back cover*)
 12. **Xiangming Xu**, Zhenwei Wang, Sergei Lopatin, Manuel A Quevedo-Lopez, Husam N Alshareef, Wafer-scale quasi single crystalline MoS₂ realized by epitaxial phase conversion, *2D Materials*, 2018, 6, 015030.
 13. Ximei Zhai[§], **Xiangming Xu**[§], Xiaoliang Zhu, Yongjie Zhao, Jingbo Li, Haibo Jin, Porous layer assembled hierarchical Co₃O₄ as anode materials for lithium-ion batteries, *Journal of materials science*, 2018, 53, 1356-1364. (§contributed equally)
 14. **Xiangming Xu**, Yongjie Zhao, Yuzhen Zhao, Heping Zhou, Fida Rehman, Jingbo Li, Haibo Jin, Self-assembly process of China rose-like β-Co(OH)₂ and its topotactic conversion route to Co₃O₄ with optimizable catalytic performance, *CrystEngComm*, 2015, 17, 8248-8255.
 15. **Xiangming Xu**, Yongjie Zhao, Jingbo Li, HaiBo Jin, Yuzhen Zhao, Heping Zhou, Hydrothermal synthesis of cobalt particles with hierarchy structure and physicochemical properties, *Materials Research Bulletin*, 2015, 72, 7-12.

Co-author:

1. Sebastian Pazos, **Xiangming Xu**, Tianchao Guo, Kaichen Zhu, Husam N. Alshareef, Mario Lanza*, Solution-processed memristors, *Nature Reviews Materials*, invited.
2. Lin Shi, Vinayak S Kale, Zhengnan Tian, **Xiangming Xu**, Yongjiu Lei, Sharath Kandambeth, Yizhou Wang, Prakash T Parvatkar, Osama Shekhah, Mohamed Eddaoudi*, Husam N Alshareef*, *Adv. Funct. Mater.* 2023, 2212891.
3. Emre Yarali, Jehad K. El-Demellawi, Hendrik Faber, Dipti R. Naphade, Yuanbao Lin, Kalaivanan Loganathan, **Xiangming Xu**, Wejdan S. Alghamdi, Despoina Gkeka, Linqi Lou, Emre Yengel, Temur Maksudov, Husam N. Alshareef *, Thomas D. Anthopoulos,* Fully-Sprayed Metal Oxide Transistors with Ti₃C₂T_x MXene Contacts, *ACS Applied Electronic Materials*. <https://doi.org/10.1021/acsaelm.2c01286>
4. Jehad K. El-Demellawi, Ahmed E. Mansour, Ahmed M. El-Zohry, Mohamed N. Hedhili, Jun Yin, Abdul-Hamid M. Emwas, Partha Maity, **Xiangming Xu**, Osman M. Bakr, Omar F. Mohammed,* and Husam N. Alshareef,* Tuning the Work Function of Ti₃C₂T_x MXene by Molecular Doping without Changing its Surface Functional Groups, *ACS Materials Lett.* 2022, 4, 2480-2490.
5. Mrinal K Hota, Suman Chandra, Yongjiu Lei, **Xiangming Xu**, Mohamed N Hedhili, Abdul - Hamid Emwas, Osama Shekhah, Mohamed Eddaoudi, Husam N. Alshareef,* Electrochemical Thin-Film Transistors using Covalent Organic Framework Channel, *Advanced Functional Materials*, 2022, 2201120.
6. Gang Huang, Jun Yin, Guodong Zou, Fangwang Ming, **Xiangming Xu**, Hanfeng Liang, Zahra Bayhan, Omar F. Mohammed, and Husam N. Alshareef,* MXene Conversation to V₂S₃ Heterostructure in CS₂ Ambient: a Novel Approach for Sodium-ion Battery Anodes, *Materials Today Energy*, 2022, 30, 101184
7. Dazhen Huang, Hyunho Kim, Guodong Zou, **Xiangming Xu**, Yunpei Zhu, Kaleem Ahmad, Zeyad A. Almutairi, Husam N. Alshareef *, All-MXene Thermoelectric Nanogenerator,

- Materials Today Energy*, 2022, 29, 101129.
8. Kaichen Zhu, Chao Wen, Areej A. Aljarb, Fei Xue, **Xianming Xu**, Vincent Tung, Xixiang Zhang, Husam N. Alshareef, Mario Lanza,* Two-dimensional materials based integrated circuits, *Nature electronics*, 2021, 4, 775.
 9. Zahra Bayhan, Gang Huang, Jian Yin, **Xiangming Xu**, Yongjiu Lei, Zhixiong Liu, Husam N Alshareef,* *ACS Applied Energy Materials*, 2021, 4, 8721.
 10. Hyunho Kim, Mohamad Insan Nugraha, Xinwei Guan, Zhenwei Wang, Mrinal K. Hota, **Xiangming Xu**, Tom Wu, Derya Baran, Thomas D. Anthopoulos, Husam N. Alshareef*, All-Solution-Processed Quantum Dot Electrical Double-Layer Transistors Enhanced by Surface Charges of $Ti_3C_2T_x$ MXene Contacts, *ACS Nano*, 2021, 15, 5221
 11. Sifei Zhuo,[†] Gang Huang,[†] Yongjiu Lei, Wenxi Wang, Zhixiong Liu, **Xiangming Xu**, Jian Yin, Wenli Zhang, Hanfeng Liang, Yunpei Zhu and Husam N Alshareef*, 2D Downsized TiS_2 Nanolayers Evenly Dispersed in a 3D Carbon Honeycomb for High-Rate and Long-Life Na-Ion Battery Anode, *Small Methods* 2020, 2000439.
 12. Shaobo Tu, Lujia Xu, Jehad K. El-Demellawi, Hanfeng Liang, **Xiangming Xu**, Sergei Lopatin, Stefaan De Wolf, Xixiang Zhang*, Husam N. Alshareef*, Autonomous MXene-PVDF actuator for flexible solar trackers, *Nano Energy*, 2020, 77, 105277.
 13. Sharath Kandambeth, Jiangtao Jia, Hao Wu, Vinayak S. Kale, Prakash T. Parvatkar, Justyna Czaban-Jóźwiak[‡], Sheng Zhou Zhou, **Xiangming Xu**, Edy Abouhamad, Abdul-Hamid Emwas^{||}, Osama Shekhah[‡], Husam N. Alshareef, Mohamed Eddaoudi, Covalent Organic Frameworks Negative Electrodes for High-Performance Asymmetric Supercapacitors, *Adv. Energy Mater.* 2020, 2001637.
 14. Zhixiong Liu, Lu You, Nastaran Faraji, Chun-Ho Lin, **Xiangming Xu**, Jr-Hau He, Jan Seidel, Junling Wang, Husam N Alshareef, Tom Wu, Single Crystal Hybrid Perovskite Platelets on Graphene: A Mixed Dimensional Van Der Waals Heterostructure with Strong Interface Coupling, *Advanced Functional Materials*, 2020, 1909672
 15. Hao Wu, Maram Almalki, **Xiangming Xu**, Yongjiu Lei, Fangwang Ming, Arijit Mallick, Vladimir Roddatis, Sergei Lopatin, Osama Shekhah, Mohamed Eddaoudi, Husam N Alshareef, MXene Derived Metal-Organic Frameworks, *Journal of the American Chemical Society*, 2019, 141, 51, 20037–20042.
 16. Yongjie Zhao, Xiaowei Zhang, **Xiangming Xu**, Yuzhen Zhao, Heping Zhou, Jingbo Li, Haibo Jin, The synthesis of ultra-long cobalt chains and its outstanding catalytic performance on the thermal decomposition of ammonium perchlorate, *Materials Chemistry and Physics*, 2017, 201, 235-240.
 17. Yongjie Zhao, **Xiangming Xu**, Yuzhen Zhao, Heping Zhou, Jinbo Li, HaiBo Jin, Synthesis and their physicochemical behaviors of flower-like Co_3O_4 microspheres, *Journal of Alloys and Compounds*, 2016, 654, 523-528.
 18. Yongjie Zhao, Xiaowei Zhang, **Xiangming Xu**, Yuzhen Zhao, Heping Zhou, Jingbo Li, HaiBo Jin, Synthesis of NiO nanostructures and their catalytic activity in the thermal decomposition of ammonium perchlorate, *CrystEngComm*, 2016, 18, 4836-4843.

US patents

1. **X. Xu**, H. N. Alshareef. Large-scale Synthesis of 2D Semiconductors by Epitaxial Phase Conversion Process, US Patent **US20200357635A1**.
2. **X. Xu**, H. N. Alshareef. A Hereditary Process Technology for Growing Single-Crystalline Films on a non-single-crystalline Substrate, Publication No. **202207274**.

Book Chapters

1. **X. Xu**, H. N. Alshareef. The chapter of “MXenes for electronic and communicating devices” in the handbook of “Transition Metal Carbides and Nitrides (MXenes) Handbook: Guidelines for the synthesis, processing, properties and applications”, to be published by *John Wiley & Sons* soon.