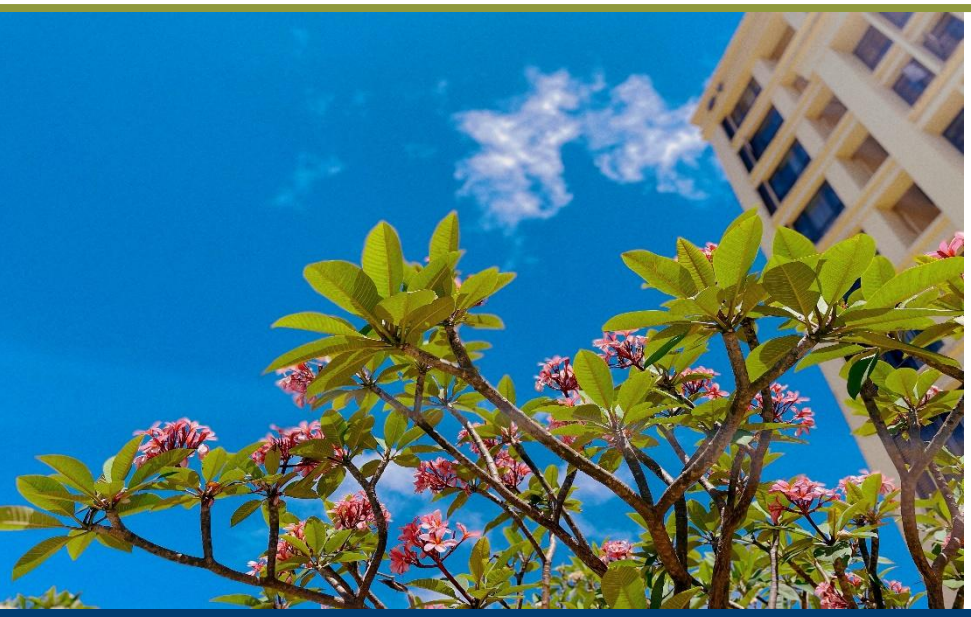
澳門大學
UNIVERSIDADE DE MACAU
UNIVERSITY OF MACAU

應用物理及材料工程研究院
INSTITUTO DE FÍSICA APLICADA E ENGENHARIA DE MATERIAIS
INSTITUTE OF APPLIED PHYSICS AND MATERIALS ENGINEERING

IAPME Newsletter

https://iapme.um.edu.mo/



ISSUE 64

10 December 2025

✧ Content

1. Research Highlights
   a. Publications
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5. Upcoming Events

❖ Publications (IF≥8, and/or nature Index; *corresponding author)

1. **Xiaoke Wang**, Sanlue Hu, Fangyuan Xiao, Guanping Xu, Zirui Zhao, Caiyun Chang, Xiangyong Zhang, Cuiping Han*, **Hai-Feng Li***, and Hui-Ming Cheng*. A Highly Water-Retentive Electrolyte Enabling Stable Aqueous Zinc-Ion Batteries Across a Wide Temperature Range. *Advanced Functional Materials.*, e19785 (2025). DOI: https://doi.org/10.1002/adfm.202519785. [2024 IF=19.0]

A Highly Water-Retentive Electrolyte Enabling Stable Aqueous Zinc-Ion Batteries Across a Wide Temperature Range

Xiaoke Wang, Sanlue Hu, Fangyuan Xiao, Guanping Xu, Zirui Zhao, Caiyun Chang, Xiangyong Zhang, Cuiping Han, Hai-Feng Li,* and Hui-Ming Cheng**

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IAPME Newsletter

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❖ Research Stories

UM & SUAT Research Teams Develop Highly Water-Retentive Electrolyte for Stable Aqueous Zinc-Ion Batteries Across a Wide Temperature Range

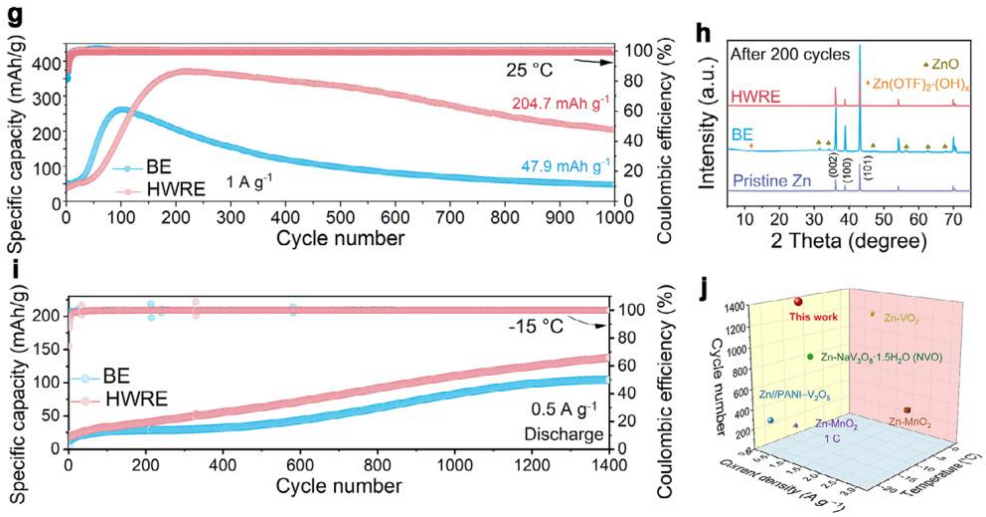
Xiaoke Wang
(王小珂)

Prof. Cuiping Han
(韓翠平)

Prof. Hai-Feng Li
(李海峰)

Prof. Hui-Ming Cheng
(成會明)

- This study successfully developed a novel highly water-retentive electrolyte (HWRE) by introducing Di (propylene glycol) methyl ether (DPM) as a co-solvent. The hydroxyl groups in DPM form a robust hydrogen bonding network with water molecules, effectively inhibiting water evaporation and enhancing electrolyte stability.
- The innovative electrolyte design significantly improves battery performance and longevity. It enables Zn/Zn symmetric cells to achieve an exceptional cycling life of over 4200 hours at room temperature and allows Zn/Cu cells to maintain a high average Coulombic efficiency of 99.8% over 2500 cycles.
- The HWRE strategy successfully extends the operational temperature range of aqueous zinc-ion batteries. Batteries incorporating this electrolyte demonstrate outstanding stability and performance across a temperature range from -20 °C to 40 °C, paving the way for energy storage applications.



Xiaoke Wang, Sanlue Hu, Fangyuan Xiao, Guanping Xu, Zirui Zhao, Caiyun Chang, Xiangyong Zhang, Cuiping Han*, **Hai-Feng Li***, and Hui-Ming Cheng*. A Highly Water-Retentive Electrolyte Enabling Stable Aqueous Zinc-Ion Batteries Across a Wide Temperature Range. *Advanced Functional Materials.*, e19785 (2025). DOI: https://doi.org/10.1002/adfm.202519785. [2024 IF=19.0]

Xiaoke Wang, a Ph.D. student co-supervised by IAPME and SIAT. This research was supported by the National Key Research and Development Program of China (2022YFB3803400), the Science and Technology Development Fund, Macao SAR (File Nos. 0104/2024/AFJ and 0115/2024/RIB2), Guangdong Basic and Applied Basic Research Foundation (2023A1515110588), Shenzhen Science and Technology Program (RCYX20221008092934093, KCXFZ20240903093918025).

❖ Ph.D. Student Thesis Oral Defenses

Zhenjian Li of Prof. Songnan Qu's group presented "Engineering Carbon Dots for Enhanced Photothermal Tumor Therapy" in his oral defense on December 1, 2025.

Congratulations to Dr. Zhenjian Li!

(from left) Prof. Yinning Zhou (周胤寧) , Prof. Songnan Qu (曲松楠), Dr. Zhenjian Li (黎鎮堅), Prof. Handong Sun (孫漢東), Prof. Bingpu Zhou (周冰朴) and Prof. Di Li (李迪, JLU)

Jinzhu Tang of Prof. Guoxing Sun's group presented "Polymer-Based Surface Modification Strategies for Performance Enhancement of Cementitious Composites" in her oral defense on December 3, 2025.

Congratulations to Dr. Jinzhu Tang!

(from left) Prof. Binmeng Chen (陳斌猛), Prof. Hongchao Liu (劉宏超), Prof. Songnan Qu (曲松楠), Dr. Jinzhu Tang (唐近朱), Prof. Zhengwu Jiang (蔣正武, Tongji University) and Prof. Guoxing Sun (孫國星)

Guangxu Ju of Prof. Guoxing Sun's group presented "Preparation and applications of poly(N-isopropylacrylamide) (PNIPAM) hydrogel by calcium hydroxide nano-spherulites (CNS) cross-linking" in his oral defense on December 3, 2025.

Congratulations to Dr. Guangxu Ju!

(from left) Prof. Binmeng Chen (陳斌猛), Prof. Yinning Zhou (周胤寧), Prof. Guoxing Sun (孫國星), Dr. Guangxu Ju (鞠光旭), Prof. Bing Chen (陳兵, SJTU) and Prof. Hui Pan (潘暉)

❖ UM Hosts Doctor *honoris causa* Lecture Featuring Prof. Ze Zhang

The University of Macau (UM) held its Doctor *honoris causa* Lecture on November 28, 2025, featuring Prof. Ze Zhang (張澤), recipient of UM's Doctor of Science *honoris causa* and a leading scholar in crystal structure research within materials science. Prof. Zhang delivered a lecture titled "*In-Situ Microstructure Study on Property Variation of Advanced Materials under Simulated Service Condition*", sharing his latest findings on the unique microstructures of quasicrystals and other functional nanomaterials, along with their potential applications.

In his introduction, UM Vice Rector & Interim Director of IAPME, Prof. Wei Ge, highlighted Prof Zhang's achievements as an outstanding microphysicist and a pioneer in quasicrystal research. Prof. Ge emphasized that Prof. Zhang's pioneering work has significantly advanced materials science and deepened understanding of nanostructure behavior and its practical applications.

During the lecture, Prof. Zhang addressed key technological challenges in the research and development of advanced materials and functional devices. He stressed that accurate characterization of microstructures and their evolution is critical for progress in the field. Prof. Zhang urged researchers to move beyond established frameworks and develop new methods and theories to tackle unresolved problems. He also offered forward-looking insights into structural evolution, emerging properties, and prospective applications of low-dimensional nanomaterials under external fields, including in-situ mechanical loading.

Dr. Lam Kam Seng Peter, Chair of the UM University Council, attended the lecture and presented a souvenir to Prof. Zhang. The event concluded with an interactive Q&A session moderated by Prof. Handong Sun, Associate Director of IAPME, where Prof. Zhang actively engaged with participants.

Following the lecture, Prof. Zhang met with representatives of our Institute to learn about UM's latest developments in research planning, talent cultivation, and technology transfer. He praised the Institute's achievements in advanced materials and functional devices and discussed topics such as disciplinary development and future strategic planning.

Prof. Zhang is currently a professor at the School of Materials Science and Engineering at Zhejiang University and serves as Chief Scientist of the National Key Basic Research Development Program. He has received numerous prestigious national science and technology awards, including the First-Class National Natural Science Award, the Ho Leung Ho Lee Foundation Science and Technology Award, and the China Young Scientist Award.


澳門大學
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UNIVERSITY OF MACAU
澳門大學榮譽博士講座
University of Macau Doctor honoris causa Lecture
模擬服役條件下
先進材料性能的顯微結構原位研究
In-Situ Microstructure Study on Property Variation of


模擬服役條件下先進材料性能的顯微結構原位研究
In-Situ Microstructure Study on Property Variation of
Advanced Materials under Simulated Service Condition
28/11/2025, 3:00 pm
張澤院士
Academician Ze ZHANG

❖ UM Confers Honorary Doctorate on Prof. Ze Zhang for Pioneering Contributions to Materials Science

On November 30, 2025, the University of Macau (UM) hosted the Ceremony for the Conferment of Honorary and Higher Degrees 2025. The event marked a significant academic occasion, celebrating achievements across various disciplines.

During the ceremony, UM conferred an honorary doctorate upon Prof. Ze Zhang (張澤), a distinguished scholar in crystal structure and materials science. The recognition was awarded in acknowledgment of his exceptional academic accomplishments and his substantial contributions to society.

❖ IAPME Graduates Attended Ceremony for the Conferment of Higher Degrees 2025

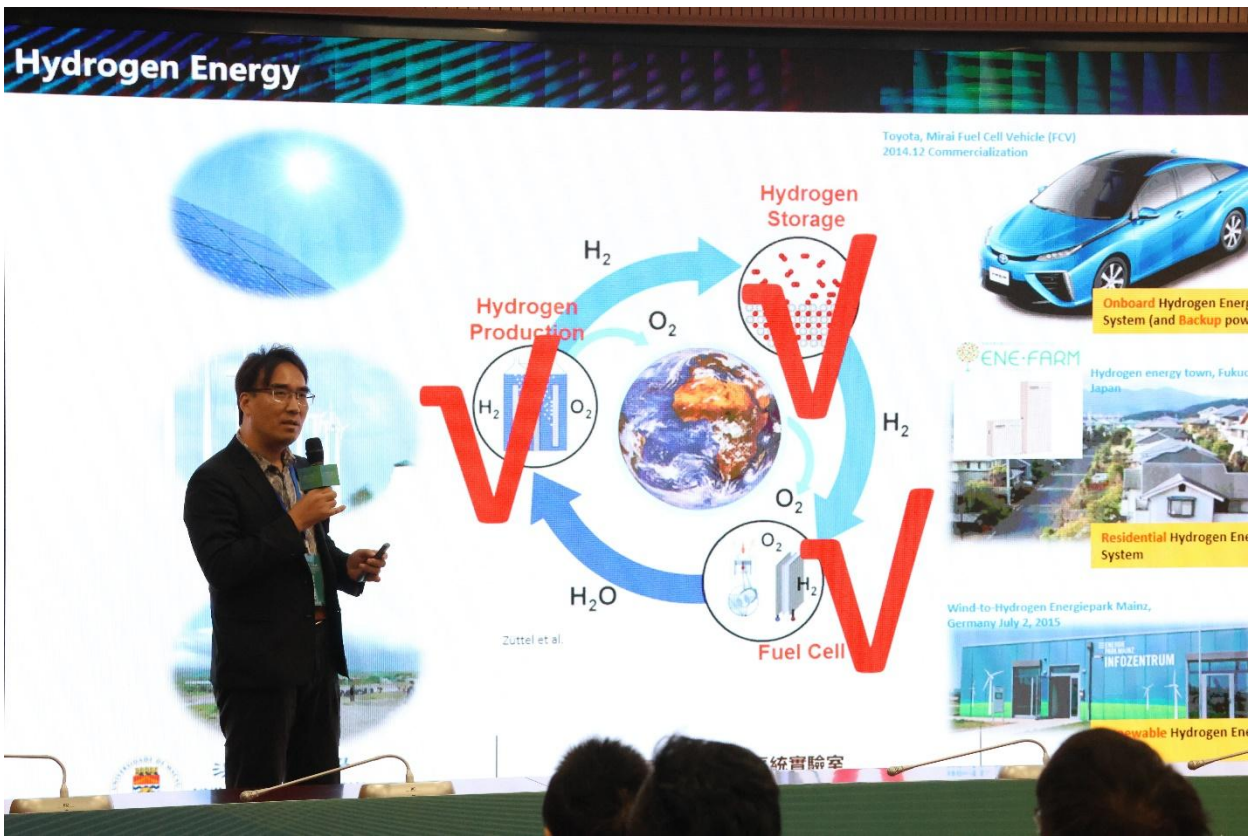
On November 30, 2025, the University of Macau (UM) held the Ceremony for the Conferment of Higher Degrees 2025.

This year, 7 doctoral graduates and 6 master's graduates from our Institute participated in the commencement ceremony. We extend our heartfelt congratulations to all graduates and wish them every success in their future endeavors.

❖ News

On November 21, 2025, Foshan University hosted the *2025 Guangdong-Hong Kong-Macao University Hydrogen Energy Innovation Alliance Academic Forum* at its Jiangwan Campus. The event brought together leading experts and scholars from alliance member institutions, including City University of Hong Kong, The Hong Kong University of Science and Technology, University of Macau, South China University of Technology, Bosch (China), Foshan Xianhu Laboratory, and Foshan Institute of Environment and Energy. Prof. Huaiyu Shao attended the forum as an invited speaker and delivered a presentation.

Other participants delivered academic presentations showcasing the latest research achievements and industry trends in hydrogen energy technology. Discussions focused on critical technological bottlenecks and potential breakthrough directions across the hydrogen energy industrial chain. These exchanges are expected to significantly benefit hydrogen energy research and development efforts at the University of Macau and other member institutions.



The Guangdong-Hong Kong-Macao University Hydrogen Energy Innovation Alliance was jointly initiated by Foshan University, South China University of Technology, The Hong Kong University of Science and Technology, and University of Macau, and was officially approved in July 2024. The successful convening of this forum marks a major step toward deepening resource sharing and collaborative innovation in hydrogen energy across Guangdong, Hong Kong, and Macao.

By fostering academic and industrial partnerships, the forum plays a pivotal role in accelerating research, application, and commercialization of hydrogen energy technologies in Guangdong Province and the Greater Bay Area. It also contributes to overcoming key common technological challenges within the hydrogen energy industrial chain.

❖ Seminars

On November 26, 2025, our Institute hosted a seminar titled "*Seeing the Unseeable: A Neutron and X-Ray Vision into Energy Storage Materials*." The event featured Prof. Kun Qian (錢坤) from Great Bay University as the keynote speaker and was chaired by Prof. Qing Li.

Prof. Qian, an Assistant Professor at Great Bay University, specializes in applying advanced synchrotron X-ray and neutron scattering techniques to investigate material structures and degradation mechanisms. With more than seven years of hands-on experience at world-leading facilities—including the Advanced Photon Source at Argonne National Laboratory and the China Spallation Neutron Source—alongside numerous publications in top-tier journals, Prof. Qian brought exceptional expertise and insight to the discussion.

During his presentation, Prof. Qian addressed one of the most pressing challenges in battery research: characterizing light elements such as lithium. He explained how a suite of complementary techniques—including Neutron Depth Profiling (NDP) for lithium mapping, Neutron Powder Diffraction (NPD) for bulk crystal analysis, and the combined use of SANS and SAXS/WAXS for probing nanoscale structures—offers a multi-scale perspective that bridges the critical knowledge gap between material degradation and performance decline.

The seminar concluded with an engaging discussion session, where students and researchers actively explored the nuances and future applications of these advanced characterization methods. The event served as a dynamic platform for academic exchange, leaving participants with a deeper appreciation for the role of large-scale facilities in advancing energy storage technologies.

On December 1, 2025, Prof. Jun Lu (陸俊), a leading authority in battery materials and synchrotron-based diagnostics, delivered an invited seminar titled "*High Energy Battery Materials and Advanced Characterization*". The event, hosted by Prof. Kwun Nam Hui, attracted researchers and students eager to explore the latest developments in energy storage science.

Prof. Lu is internationally recognized for his pioneering work on structural degradation mechanisms in layered oxide cathodes. His extensive publication record and influential contributions have shaped the understanding and optimization of high-energy-density electrode materials.

Prof. Lu began by underscoring the growing demand for high-performance lithium-ion batteries, driven by the rapid expansion of new energy vehicles and large-scale storage systems. These applications require cathode materials with superior energy density and extended cycle life. However, unresolved failure mechanisms in current materials remain a critical barrier to progress.

To address this challenge, Prof. Lu's team employed advanced synchrotron radiation techniques to investigate performance degradation in layered cathode materials under realistic operating conditions. This approach enabled unprecedented insights into structural evolution during battery operation.

A major breakthrough presented during the seminar was the discovery of a fundamental link between localized stress–strain accumulation and the formation of lattice microcracks in layered cathodes. Prof. Lu explained that lithium intercalation and deintercalation generate stress concentrations, leading to structural distortion, crack initiation, and eventual capacity fading. This mechanistic understanding resolves a long-standing question about the intrinsic origin of structural degradation in high-energy cathode materials.

The seminar concluded with an interactive Q&A session, where participants explored topics such as operando characterization, stress-regulation strategies, and innovative design principles for next-generation cathodes. Prof. Lu's visit fostered meaningful research exchange and reaffirmed a shared commitment to advancing battery science through cutting-edge characterization and mechanism-driven design.

❖ Upcoming Events

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IAPME Seminar

Design of Layered Materials and Interfaces by First-principles Method

11 December 2025

Prof. Ming YANG
Hong Kong Polytechnic University
Venue: N23-3022
Time: 11:00 - 12:00
Hosted by: Prof. Yongqing CAI

Abstract

Two-dimensional materials has gained great attentions for implications in nanoelectronics and photonics. The optical and electronic properties of two-dimensional materials supported on copper-based superconductors is presented. Notably, when monolayer-WSe_2 is placed on $La_{1.85}Sr_{0.15}CuO_4$ (WSe_2/LSCO), it exhibits a distinctive band structure that sets it apart from monolayer-WSe_2 supported on other substrates. Through the application of high-resolution spectroscopic ellipsometry and density functional theory calculations, we have determined that this unique electronic structure can be attributed to the formation of an interfacial small polaron at the WSe_2/LSCO interface. This formation is driven by charge transfer between the CuO_2 plane of the cuprate superconductor and the WSe_2 layer. In addition, we present an efficient high-throughput screening high-κ dielectrics from a large materials database, of which 2D $Sb_2S_2O_9$, two Bi_2O_3 phases, $As_2S_2O_9$, Sb_2O_3, and $Te_2H_2O_3F_4$ have been predicted to be the most promising gate dielectrics due to their optimal trade-off between dielectric constant and band gap, as well as facile growth possibility.

Biography

Prof. Ming YANG is currently an Assistant Professor at Hong Kong Polytechnic University in Department of Applied Physics. He obtained his Bachelor at Fujian Normal University in 2001 and PhD at National University of Singapore in 2010. His recent research focuses on accelerating the development of functional materials using high-throughput screening techniques, large-scale DFT calculations, and machine learning. Prof. Yang also engaged in developing 2D electronic and spintronic devices, as well as exploring the electronic, magnetic, topological, and optical properties of 2D materials and their heterostructures. To date, Prof. Yang has published over 200 peer-reviewed papers in renowned journals such as Science, Nat. Mater., Nat. Electron., Nature Nanotech., PRL, Adv. Mater., and JACS. Prof. Yang's work has received more than 9000 citations, with an H-index of 50 (as of November 2025, Google Scholar). Additionally, Prof. Yang have contributed to two book chapters and filed three PCT patents.

Enquiry: iapme.enquiry@um.edu.mo

IAPME Seminar

Laser-based light regulation technology and its application in Greenhouse agriculture

17 December 2025

Prof. Minglai YANG
Jilin Agricultural University
Venue: N23-4018
Time: 14:00 - 15:00
Hosted by: Prof. Songnan QU

Abstract

Facility agriculture faces the problem of light shortage. Traditional light sources such as LED have high energy consumption and limited use. Urgent need for a new generation of light sources to solve industrial problems. This report discusses the characteristics of laser technology and its application in greenhouse agriculture, focusing on the key technologies and application progress of laser to promote plant photosynthesis, including: Research progress of laser plant lighting equipment, Mechanism of laser promoting crop photosynthesis, Laser light supplement promotes facility planting to improve quality and efficiency, Laser irradiation enhances seed activity and promotes yield increase. Reducing energy consumption of factory planting by laser lighting. Laser system has become a new equipment for facility agriculture, which has opened a new door for greenhouse agriculture.

Biography

Prof. Minglai YANG, Professor, doctoral tutor, National-Level Leading Talent in Scientific Research, outstanding engineer in Zhejiang Province, class B talent in Jilin Province, deputy director of academic committee of Jilin Provincial Key Laboratory of Light Agriculture, leader of laser agriculture discipline in Jilin Agricultural University, is mainly engaged in the application of laser technology to agriculture, conducting in-depth research in the fields of laser-promoted photosynthesis mechanism, interaction mechanism with animals and plants, and laser agricultural equipment development. At present, he is committed to the integrated technology research of laser combined with smart agriculture applied to facility fruit and vegetable factories, plant factories, rice seedling factories, seed industry rapid propagation accelerators and so on. He has published more than 80 papers and authorized more than 20 invention patents. The developed technology and products are widely used in more than 150 bases in 24 provinces across China.

Enquiry: iapme.enquiry@um.edu.mo