

M.E. in Chemical Engineering & Technology (English-taught)

1. Program Overview

The nationally acknowledged Chemical Engineering Master of Engineering (MChE.) Program in Donghua University was established in 1978. It is currently administrated by the college of Chemistry, Chemical Engineering and Biotechnology (CCCEB). The MChE program has a focus in applied research and is especially designed to provide excellent preparation for students who will be seeking employment in industry. ChE faculty have taken charge of over 100 research projects funded by the national and provincial ministries, which resulted in over 300 journal publications, almost 200 patent applications, and numerous awards for the advancement of science and technology. We maintain a high faculty/student ratio and operate an open-door policy for faculty offices whereby students are free to stop in to discuss their research, science, careers or life in general. Incoming students may choose to study in the three sub-disciplines of Applied Chemical Engineering, Bioengineering and Process Chemistry. The program has graduated over 400 master students and there are approximately 100 students currently enrolled.

ChE program has acquired an inventory of state-of-the-art research equipment and instrumentation including a Bruker Avance 400 nuclear magnetic resonance (NMR) spectrometer, a gas chromatograph mass spectrometer (GC/MS), an electrospray liquid chromatography/mass spectrometers (LC/MS), high performance liquid chromatographs (HPLC), gas chromatographs (GC), Fourier Transform Infrared (FTIR) spectrometers, spectro-fluorimeters, UV/Vis spectrophotometers, rheometers, minimum temperature film forming bars and more.

2. Requirements and Objectives

Admission is in accordance with the general requirements of the graduate division. Students with a B.S. or B.E. in chemical engineering, chemistry, bioengineering or related disciplines are welcome to apply. Applicants are judged competitively based on the candidate's background, qualifications, and goals. The mission of the Chemical Engineering Master Program is to provide the next generation of chemical engineers with an excellent and innovative chemical engineering education.

The primary goals are:

- To prepare students for rapidly changing technological environments with the core principles of chemical engineering and analytical problem-solving skills necessary to succeed in diverse careers including chemical engineering practice and academic research.
- To provide students with a strong technical education that will enable them to use the techniques, skills and modern engineering and computing tools necessary for practice in diverse fields as fine chemical engineering, functional polymers, bio materials, greener technologies, natural product synthesis, and biosynthesis.

•To instill in students a strong sense of humanistic values and professionalism such that they will have a sense of responsibility, be ethical in the conduct of their profession, they can conduct ethically and have an appreciation for the impact of their profession on society.

Graduates from the program may choose to pursue a doctorate degree in ChE or a career in research and development, production management and technical support.

3. Research orientation

- (1) **Fine chemical engineering:** research based on development of novel textile chemicals, aerospace chemicals, pharmaceutical intermediates employing the principles of green chemistry.
- (2) **Fermentation engineering and textile biotechnology:** an interdisciplinary research area with the focus on microbial fermentation, enzyme engineering and the application of biotechnology in textile processing.
- (3) **Textile chemical engineering:** A discipline based on the traditional textile dyeing and finishing extended and enriched with inputs from related disciplines of material science, environmental engineering and applied chemistry.
- (4) **Functional polymers and nanotechnology:** An emerging new field aiming at fulfilling the growing demand for new medical-textiles and functional textiles. Specific areas include biomedical materials, functional microcapsules, and nano hydrogels.

4. Course requirements

All students must complete a total of 34 credits which must include 10 credits from the compulsory general education courses, 12 credits from the major compulsory courses, and 12 credits from the elective courses.

(1) Compulsory Course (total credits 12)

a) Organic Synthesis: Strategy and Control (3 credits)

Course Description: The main contents of this course are: 1) understand a series of important organic reactions and carbon-carbon formation, 2) understand the basic theory of retrosynthesis and the basic principle of its application on the synthesis of complicated molecule.

Prerequisites: A basic background in organic chemistry and inorganic chemistry is require.

b) Organometallic Chemistry (3 credits)

Course Description: The major contents of this course are: 1) understand the basic principles of electronics, structure and bonding in inorganic and organometallic complexes; 2) understand elementary

organometallic steps in the context of catalysis; 3) design organometallic catalysts for important organic transformations; 4) explore use of organometallic complexes in other fields like medicine.

Prerequisites: A basic background in organic chemistry and inorganic chemistry is required. Some background in physical chemistry is helpful, but not required.

c) Biochemistry (3 credits)

Course Description: This course is designed for beginning graduate students in Chemical Engineering and Technology. The main contents of this course include: 1) biosynthesis, structure, and function of carbohydrates, proteins, lipids, and nucleic acids, and survey of modern biochemical techniques; 2) regulation of gene expression and metabolic control mechanisms; 3) membrane biochemistry and signal transduction mechanisms.

Prerequisites: organic chemistry, inorganic chemistry, or consent of instructor.

d) Advanced Organic Lab Experiments (3 credits)

Course Description: This course concerns the application of the tools of chemistry to the synthesis of organic molecules, the separation of mixtures of organic compounds, and the subsequent identification of these compounds. It focuses on discovery-based learning, i.e. the concept that learning comes as you solve various organic chemistry puzzles. In the laboratory, students should run 6-8 synthetic experiments. In some cases, there will not be provided with the structures of the products. As for the products with unknown structures, students must determine by the interpretation of infrared, NMR, and mass spectral data. Each of the basic experiments requires a written report, formatted in the style of papers in the Journal of the American Chemical Society.

(2) Optional Course (total credits 12)

a) Bio-medical Materials (3 credits)

Course Description: The major contents of this course are: 1) to understand the basic knowledge about inorganic and organic biomaterials; 2) to understand the process of functionalization of biomaterials and biocomposite materials; 3) to grasp the knowledge of the design of biocompatibility tests of biomaterials for different biomedical applications; and 4) to have knowledge of the use of bio-medical materials and nanomaterials in the fields of tissue engineering, drug delivery, medical diagnosis and therapy.

Prerequisites: A basic background in chemistry, chemical engineering, materials science, life sciences, biomedical engineering or bioengineering is required.

b) Green Chemistry (3 credits)

Course Description: The course introduced the key concepts of green chemistry such as renewable resources, atom economy, biodegradability and life cycle assessment as well as the 12 principles of green chemistry. The tools of green chemistry including the use of alternative feedstocks or starting materials, reagents, solvents, target molecules, and catalysts will be covered. Particular attention is

focused on the application of innovative technology in the development of "greener" routes to improve industrial processes and to produce important green consumer products.

Prerequisites: The students are expected but not required to have some basic knowledge of general chemistry, organic chemistry and biochemistry.

c) Textile Chemistry (3 credits)

Course Description: This course focuses on the dyestuff, auxiliary, dyeing printing and finishing theory and technology. It also includes the knowledge of fibers, both natural and synthetic. The dyeing and finishing aspects of textile chemistry require an understanding of both organic chemistry and surface chemistry. Textile chemistry also includes the application of the principles of surface chemistry to processes, such as dyeing and finishing.

d) Advanced materials science and engineering (3 credits)

Course Description: Nanomaterials science and application is novel research area that attracts people's attention. Nanomaterials will create significant economic benefits and greatly have positive impact on the development of human society. This course will highlight the preparation principles and technique processes of nanomaterials and introduce the practical applications and the future development trends.

e) Surfactant Chemistry (3 credits)

Course Description: The content of this course focuses on the principle of physical chemistry and application for surfactants. It concerns the selecting and molecular designing for some special surfactants in a particular situation. Many application and research examples would be mentioned.

Prerequisites: The students are expected but not required to have some basic knowledge of organic chemistry and physical chemistry.

5. Faculty

(1) **Dr. Xihua Lu (Doctoral Supervisor):** Dr. Lu is a distinguished professor in College of Chemistry, Chemical Engineering and Biotechnology, Donghua University. He received his Ph.D. of Materials Science and Engineering from University of North Texas in 2002. He then worked as a Research Fellow at the Northwestern University from 2003-2006. Before returning to China, he acted as the Research Fellow in the International Flavors & Fragrances Inc. Now, he is one of the "Thousand Talents program" distinguished experts in Shanghai. His research interests focus on the preparation and application of intelligent polymer hydrogels, nano hydrogels, and polymeric microcapsule. Selected recent publications:

- a) Liao, Q., Shao, Q., Qiu, G., **Lu, X.** Methacrylic acid-triggered phase transition behavior of hydroxypropyl cellulose. *Carbohydrate Polymers* **2012**, 89, 1301-1304.
- b) Liao, Q., Shao, Q., Wang, H., Qiu, G., **Lu, X.** Hydroxypropyl-cellulose-templated synthesis of poly(acrylic acid) nanogels in aqueous media. *Carbohydrate Polymers* **2012**, 87, 2648-2654.

c) **Lu, X.**, Sun, M., Barron, A. Non-Ionic, thermo-responsive DEA/DMA nanogels: synthesis, characterization, and use for dsDNA separations by microchannel electrophoresis. *Journal of Colloid and Interface Science* **2011**, 357, 345.

(2) **Dr. Bo Xu (Doctoral Supervisor):** Dr. Xu is a professor in College of Chemistry, Chemical Engineering and Biotechnology, Donghua University. He received his PhD from University of Louisville in 2008, and he was the recipient of 2013 Thousand Youth Talent Program. Before he returned to China, he was a research assistant professor in University of Louisville (2008-2014). Dr. Xu's research interests include organic synthesis method development, study of reaction mechanism, medicinal chemistry, and organic synthesis automation. Dr. Xu has authored more than 56 SCI peer reviewed journal articles (include 4 *JACS* and 5 *Angew. Chem.*), and he was the first or corresponding author in most of them. Dr. Xu is the inventor of anti-cancer compound XB05 (US and PCT patent granted). He is also the inventor of Rigid SolventTM technology, which can speed up organic synthesis operation significantly. Dr. Xu is also the co-founder of two start-up companies (Rigid Solutions LLC and Kynetic Pharma LLC). Two synthetic reagents developed by Dr. Xu have been commercialized by Sigma-Aldrich (cat. No. L511854 and L511846). Selected recent publications:

a) **Xu, B.**; Hammond, G. B. *Org. Lett.* **2014**, 16, 5238.

b) Okoromoba, O. E.; Han, J.; Hammond, G. B.; **Xu, B.** *J. Am. Chem. Soc.* **2014**, 136, 14381.

c) Malhotra, D.; Mashuta, M. S.; Hammond, G. B.; **Xu, B.** *Angew. Chem. Int. Ed.* **2014**, 53, 4456.

(3) **Dr. Xiangyang Shi (Doctoral Supervisor):** Dr. Shi is a professor in College of Chemistry, Chemical Engineering and Biotechnology, Donghua University. He received his Ph.D. of organic chemistry from Institute of Photographic Chemistry, the Chinese Academy of Sciences in 1998. From 2002-2008, he worked as a Research Fellow, Research Associate II, Research Investigator, and Research Assistant Professor at the University of Michigan, Ann Arbor. He then became a professor of special appointment both in Donghua University and in Shanghai Institutions of High Learning (Eastern Scholar) since 2008. Since 2010 he has been also appointed as an "Invited Chair in Nanotechnology" at University of Madeira, Portugal. His research expertise includes dendrimer chemistry and related nanomedicinal applications, in particular cancer diagnosis and therapy. He is also developing nanofiber-based technology with an emphasis on the synthesis and fabrication of bioscaffolding materials in tissue engineering applications and the immobilization of reactive nanoparticles within nanofibrous mats for environmental applications. Prof. Shi has authored or coauthored 179 SCI-indexed peer-reviewed journal articles and 168 technical conference abstracts or proceeding papers, along with 7 invited book chapters and 35 approved patents. Selected recent publications:

a) Jingchao Li, Yong Hu, Jia Yang, Ping Wei, Wenjie Sun, Mingwu Shen,* Guixiang Zhang,* **Xiangyang Shi***. Hyaluronic Acid-Modified Fe₃O₄@Au Core/shell Nanostars for Multimodal Imaging and Photothermal Therapy of Tumors. *Biomaterials* **2015**, 38, 10-21.

- b) Jingyi Zhu, Linfeng Zheng, Shihui Wen, Yueqin Tang, Mingwu Shen, Guixiang Zhang,* **Xiangyang Shi***. Targeted Cancer Theranostics Using Alpha-Tocopheryl Succinate-Conjugated Multifunctional Dendrimer-Entrapped Gold Nanoparticles. *Biomaterials* **2014**, 35, 7635-7646.
- c) Shihui Wen, Qinghua Zhao, Xiao An, Jingyi Zhu, Wenxiu Hou, Kai Li, Yunpeng Huang, Mingwu Shen, Wei Zhu*, **Xiangyang Shi***. Multifunctional PEGylated Multiwalled Carbon Nanotubes for Enhanced Blood Pool and Tumor MR Imaging. *Adv. Healthcare Mater.* **2014**, 3, 1568-1577.

(4) **Dr. Zhao Tao (Doctoral Supervisor)**: Dr. Zhao Tao, the visiting scholar in University of California, Davis, is a professor in the department of Textile Chemistry and Dyeing and Finishing Engineering at Donghua University. His interests focus on the textile dyeing and finishing technology, the development of novel textile chemicals, and the application of biomaterials in textile dyeing and finishing. He has published over 60 papers in *Textile Research Journal*, *Coloration Technology*, *Carbohydrate Polymers*, *Journal of Surfactants and Detergents*, *Journal of Applied Polymer Science*, *Journal of Applied Microbiology*, etc., and has been authorized 14 national invitation patents. Selected recent publications:

- a) Ming Wang, **Tao Zhao***. Gehui Wang, Jinli Zhou, Blend films of human hair and cellulose prepared from an ionic liquid. *Textile Research Journal*, **2014**, 84: 1315-24.
- b) Chen Qin, **Zhao Tao***. Studies of the fibre structure and dyeing properties of *Calotropis gigantea*, kapokand cotton fibres, *Coloration Technology*, **2013**, 129: 448-53
- c) Hong Pan, **Tao Zhao***. Synthesis and characterization of aminated lignin, *International Journal of Biological Macromolecules*, **2013**, 59: 221-226

(5) **Dr. Wei-dong Meng (Master's Supervisor)**: Dr. Meng is a professor in College of Chemistry, Chemical Engineering and Biotechnology, Donghua University. She received her PhD from the University of East Anglia in 1990. She spent two years (1991-1993) in the Department of Chemistry in the University of Exeter for the post-doctoral work. Her research interests are based on the synthesis and application of the functional materials. Selected recent publications:

- a) Zhu, M., Qing, F.-L., **Meng, W-D**. Novel waterborne polyurethanes containing short fluoroalkyl chains: Synthesis and Applications on Cotton. *J. Appl. Polym. Sci.*, **2008**, 109, 1911-1915.
- b) Yang Bin-bin, Qing Feng-ling, **Meng Wei-dong**. Synthesis of Novel Fluorinated Acrylate Co-polymers and their Application on Cotton Fabrics. *Journal of Donghua University* (Eng. Ed.) **2010**, 27(1), 19-24.

(6) **Dr. Xiaoyue Zhu (Master's Supervisor)**: Dr. Zhu is an Associate Professor in the College of Chemistry, Chemical Engineering and Biotechnology, Donghua University. She received her Ph.D. in Biomedical Engineering at the University of Michigan – Ann Arbor in 2005. She is interested in developing novel nanomaterials and lab-on-a-chip platforms for biological and medical applications, understanding cell and microenvironment interaction, and the regulation of cell function. Dr. Zhu has authorized 12 papers, 2 book chapters, and applied for four patents. Selected recent Publications:

- a) Moraes C, Choul KB, **Zhu XY**, Mills KL, Dixon AR, Thouless MD, Takayama S. Defined topologically-complex protein matrices to manipulate cell shape via three-dimensional fiber-like patterns. Lab-on-a-chip, **2014**, 14, 2191-2201
- b) **Zhu XY**, Mills KL, Peters PR, Bahng JH, Liu EH, Shim J, Naruse K, Csete ME, Thouless MD, Takayama, S. Fabrication of reconfigurable protein matrices by cracking. Nature Materials. **2005**, 4, 403-406
- c) Gu W, **Zhu XY**, Futai N, Cho BS, Takayama S. Computerized microfluidic cell culture using elastomeric channels and Braille displays. Proc. Natl. Acad. Sci. U. S. A., **2004**, 101, 15861-15866

(7) **Dr. Yangen Huang (Master's Supervisor):** Dr. Huang is an associate professor in College of Chemistry, Chemical Engineering and Biotechnology, Donghua University. He received his PhD from Shanghai Institute of Organic Chemistry, Chinese Academy of sciences in 2004. He was engaged in the research work as the post-doctor at the University of New South Wales (2004-2005) and the University of Idaho (2006-2008). His research interests focus on the design and synthesis of new fluorine-containing building blocks and ionic liquids with applications in organic synthesis. Selected recent publications:

- a) Yang, Yanmei **Huang, Yangen***; Qing, Feng-Ling. "Asymmetric synthesis of trifluoromethylated aziridines from CF₃-substituted N-tert-butanesulfinyl ketimines" Tetrahedron Lett, **2013**, 54, 3826-3830.
- b) Liu, Yingle; **Huang, Yangen***; Qing, Feng-Ling. "Asymmetric synthesis of β-aryl-β-trifluoromethyl-β-aminoarones via Mannich-type reactions of ketone enolates with chiral aryl CF₃-substituted N-tert-butanesulfinyl ketimines". Tetrahedron, **2012**, 68, 4955-4961.
- c) Hu, Huawei; **Huang, Yangen***; Guo, Yong. "Henry reaction of fluorinated nitro compounds". J. Fluorine Chem. **2012**, 133, 108-114.

(8) **Dr. Bijia Wang (Master's Supervisor):** Dr. Wang is an associate professor in College of Chemistry, Chemical Engineering and Biotechnology, Donghua University. She received her PhD in organic chemistry from the University of Nebraska Lincoln in 2010. Dr. Wang's research interest involves two main aspects. One is the development of greener techniques and products for textile dyeing and finishing, which is supported by the national high-technology research (863) program. Specific research topics includes screening and risk assessment of textile chemicals, formaldehyde-free Durable-press finishing agents (cross linkers) for cotton based on citric acid, and solvent dyeing of cellulosic fabrics. The other is the development of facile synthetic methods for ¹⁸F labeled Positron Emission Tomography radio tracers supported by the national youth NSF fund. Selected recent publications:

- a) **Wang, B.**, Ruan, X., Chen, L., Chen, J., & Yang, Y. (**2014**). Industrial & Engineering Chemistry Research.

b) Liu, L., Chen, Z., **Wang, B.**, & Yang, Y. (2014). Journal of Applied Polymer Science.

c) Kang, Y., Chen, Z., **Wang, B.**, & Yang, Y. (2014). Industrial Crops and Products, 56, 105-112.

(9) **Dr. Yan Luo (Master's Supervisor)**: Dr. Luo is an associate professor in College of Chemistry, Chemical Engineering and Biotechnology, Donghua University. She received her PhD of textile chemistry and dyeing and finishing engineering from Donghua University in 2002. Dr. Luo was the recipient of 2008 'Youth science and technology innovation talents' of Shanghai. As a visiting scholar, she joined the research group of Dr. Yiqi Yang in the university of Nebraska-Lincoln. Her research interests focus on the preparation and application of fine chemical, microcapsules technology, and green finishing process. Selected recent publications:

a) Wenqing He, Dangdang Cheng, Juan Du, **Yan Luo***. High Performance Synthetic Paper Used for Color Printing Based on Ultrahigh Molecular Weight Polyethylene/SiO₂ [J]. Journal of applied polymer science. 2015, DOI: 10.1002/APP.41529.

b) **Yan Luo***, Jing Zhang, Yi Qi, Yi Zhong, and Juan Du. Esterified Alizarin Used for PET Fabric Clean Dyeing[J]. Fibers and Polymers. 2014, 15(10):2124-2130.

c) Peng Liu, Yi Zhong, **Yan Luo***. Preparation of monodisperse biodegradable magnetic microspheres using a novel T-shaped microchannel reactor [J]. Materials letters, 2014, 117: 37-40

6. Students in the Lab

