

Curriculum Vitae

Xiang Ma, Ph.D.

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EDUCATION

Ph.D. in Biochemistry, Indiana University, Bloomington, IN Aug. 2008-Nov. 2013

Minor: Materials Science

Thesis: Studies of biomolecular interactions using Atomic Force Microscopy. Applications to DNA condensation, holdfast adhesion and virus elasticity.

Advisor: Dr. Bogdan Dragnea

GPA 3.9/4.0

M.S. in Biochemistry, Nanjing University, Nanjing, China Sept. 2004-July 2006

Thesis: Fabrication of hydrogen peroxide biosensors utilizing direct electrochemistry of hemoglobin and myoglobin immobilized in biological membranes.

Advisor: Dr. Genxi Li

GPA 3.8/4.0

B.S. in Biochemistry, Nanjing University, Nanjing, China Sept. 2000-July 2004

Thesis: Direct electrochemistry and electrocatalysis of hemoglobin in poly-3-hydroxybutyrate membrane.

Advisor: Dr. Genxi Li

GPA 3.7/4.0

RESEARCH EXPERIENCE

Research/Adjunct Assistant Professor Aug. 2015-present
Idaho State University, Pocatello, ID

- Study the conformational change and self-assembly of proteins using *in situ* AFM to understand the mechanism of disease.
- Fabricate ultra-sensitive biosensors for early diagnosis of disease by detecting important biomarkers.
- Understand the effects of genetic variations on drug response and drug metabolism by genotyping and DNA sequencing.
- Develop drug delivery systems based on virus-like particles.

Postdoctoral Research: (Mentor: Dr. James De Yoreo) Dec. 2013-Aug.2015
Pacific Northwest National Laboratory, Richland, WA

- Developed high-information content peptoid polymers that can self-assemble into higher order structural motifs and mimic the ability of proteins and peptides.
- Characterized the dynamics of peptoid network assembly in real time using *in situ* AFM, to determine the self-assembly pathways and the thermodynamic and kinetic parameters as a function of polymer length, sequence and chemistry.

- Explored the energy landscape of peptoid-peptoid and peptoid-substrate interactions using Dynamic Force Spectroscopy (DFS)

Doctoral Research:

Aug. 2008-Nov. 2013

Department of Molecular and Cellular Biochemistry, Indiana University, Bloomington, IN

- Investigated the dynamics of force development of a biopolymer adhesive, holdfast, using DFS; determined that holdfast adhesion is strongly time-dependent and involves transformations at multiple time scales; and developed a mathematical kinetic model to describe the time-dependence of holdfast adhesion from a molecular level.
- Demonstrated that brome mosaic viruses containing different RNA molecules can be distinguished by mechanical measurements, while they are indistinguishable by electron microscopy, suggesting that other forces than electrostatics play an important role in the encapsidation of virus RNA genomes.
- Synthesized and functionalized metal-nanoparticles for self-assembly of virus-like particles (VLPs), and characterized nanoparticles and VLPs using AFM and TEM.
- Examined the distribution of elasticity on single self-assembled hepatitis B VLP and the effect of salinity on the elasticity, using AFM force-volume mapping; and discovered a non-uniform distribution of elasticity and a soften effect of high ionic strength, providing evidence to explain viral RNA release mechanisms.
- Engineered two fluorescent proteins (FP) to the surface of Sindbis virus for *in vivo* single-particle tracking, and systematically evaluated the binding and infectivity of the FP-modified virus to mammalian cells, providing the biochemical physical basis for real-time visualization and tracking of single virus particles in living organisms.
- Revealed dynamic conformational changes of MukB proteins affected by magnesium, and studied MukB-dependent DNA condensation, using AFM imaging.
- Designed and fabricated micro-fluidic devices using photolithography for cell-tracking; and nano-fluidic devices using e-beam lithography for single molecule studies.

Research Assistant:

Aug. 2006-July 2008

Department of Biology, University of Utah, Salt Lake City, UT

- Identified disease risk-associated genes, such as erythropoietin and toll-like receptor 3, and proposed a role of viral dsRNA in the development of age-related macular degeneration (AMD).
- Demonstrated that two polymorphisms of the HTRA1 gene were among the most significantly associated variants for advanced forms of AMD, by genotyping additional variants in the AMD risk-associated region.
- Discovered significant associations between LOXL1 gene variants and exfoliation glaucoma in a Utah cohort, and uncovered a potential role of cross linking of elastin in the development of exfoliation glaucoma, providing critical information to guide glaucoma monitoring efforts and treatments.

Master's and Undergraduate Research:

May 2003-July 2006

Department of Biochemistry, Nanjing University, Nanjing, China

- Designed and fabricated low-cost, non-toxic and highly sensitive hydrogen peroxide biosensors based on direct electrocatalysis of hemoglobin (Hb) immobilized in biomembranes.

- Investigated the catalytic ability of Hb toward the reduction of nitric oxide and trichloroacetic acid (TCA) using cyclic voltammetry, and proposed a pathway of reductive dehalogenation of TCA.
- Developed an electrochemical method to assay enzymatic activities of enzymes with no electrochemical activities, and provided evidence of the effect of Zinc ions on the functionality of immune cells.
- Investigated the effect of amino acids in the active site of proteins on the electron transfer activity of kaempferol, and developed a simple model to study the electron transfer activities of small active organic molecules in specific environment.

PUBLICATIONS

Ma, X., Newcomb, C., Chen, C., & De Yoreo, J. Tuning nucleation pathways through sequence-engineering of biomimetic polymers. (in prep.)

Ma, X., Chen, C., & De Yoreo, J. *In situ* AFM study of self-assembly pathways of two-dimensional biomimetic materials. (in prep.)

Ma, X., Li, H., Zlotnick, A. & Dragnea, B. Elasticity mapping on single particles reveals mechanistic details of hepatitis B virus and virus-like particles. (in prep.)

Hua, X., Szymanski, C., Wang, Z., Zhou, Y., **Ma, X.**, Evans, J., Orr, G., Liu, S., Zhu, Z. & Yu, X. Correlative Imaging of Single Cells in a Microchannel by ToF-SIMS and SIM. *Nature Communication*. (submitted)

Hua, X., Marshall, M., Xiong, Y., **Ma, X.**, Zhou, Y., Tucker, A., Zhu, Z., Liu, S. & Yu, X. 2D and 3D dynamic imaging of live biofilms in a microchannel by time-of-flight secondary ion mass spectrometry. *Biomicrofluidics*, 2015, 9: 031101-031102.

Vaughan, R., Tragesser, B., Ni, P., **Ma, X.**, Dragnea, B., & Kao, C.C. The tripartite virions of the brome mosaic virus have distinct physical properties that affect the timing of the infection process. *Journal of Virology*, 2014, 88: 6483-6491.

Berne, C., **Ma, X.**, Licata, N.A., Neves, B., Setayeshgar, S., Brun, Y.V., & Dragnea, B. Physiochemical properties of *Caulobacter crescentus* holdfast: a localized bacterial adhesive. *The Journal of Physical Chemistry B*, 2013, 117: 10492-10503.

Tsvetkova, I., Cheng, F., **Ma, X.**, Moore, A., Howard, B., Mukhopadhyay, S., & Dragnea, B. Fusion of mApple and Venus fluorescent proteins to the Sindbis virus E2 protein leads to different cell-binding properties. *Virus Research*, 2013, 177: 138-146.

Ni, P., Wang, Z., **Ma, X.**, Das, N., Sokol, P., Chiu, W., Dragnea, B., Hagan, M., & Kao, C.C. An examination of the electrostatic interactions between the N-terminal tail of the brome mosaic virus coat protein and encapsidated RNAs. *Journal of Molecular Biology*, 2012, 419: 284-300.

Yang, Z., Stratton, C., Francis, P.J., Kleinman, M.E., Tan, P.L., Gibbs, D., Tong, Z., Chen, H., Constantine, R., Yang, X., Chen, Y., Zeng, J., Davey, L., **Ma, X.**, Hau, V.S., Wang, C., Harmon, J., Buehler, J., Pearson, E., Patel, S., Kaminoh, Y., Watkins, S., Luo, L., Zabriskie, N.A., Bernstein, P.S., Cho, W., Schwager, A., Hinton, D.R., Klein, M.L., Hamon, S.C., Simmons, E., Yu, B., Campochiaro, B., Sunness, J.S., Campochiaro, P., Jorde, L., Parmigiani, G., Zack, D.J.,

Katsanis, N., Ambati, J., Zhang, K. Toll-like receptor 3 and geographic atrophy in age-related macular degeneration. *New England Journal of Medicine*, 2008, 359: 1456-1463.

Tong, Z., Yang, Z., Patel, S., Chen, H., Gibbs, D., Yang, X., Hau, V.S., Kaminoh, Y., Harmon, J., Pearson, E., Buehler, J., Chen, Y., Yu, B., Tinkham, N.H., Zabriskie, N.A., Zeng, J., Luo, L., Sun, J.K., Prakash, M., Hamam, R.N., Tonna, S., Constantine, R., Ronquillo, C.C., Sadda, S., Avery, R.L., Brand, J.M., London, N., Anduze, A.L., King, G.L., Bernstein, P.S., Watkins, S., **Ma, X.**, Cameon, J., Rabena, M., Goldfarb, A., Banerjee, N., Keenan, H., Mamalis, N., Perez C., Katz, B., Jorde, L.B., Li, D.Y., Aiello, L.P., Pollak, M.R., Zhang, K. Promoter polymorphism of the erythropoietin gene in severe diabetic eye and kidney complications. *Proceedings of the National Academy of Sciences*, 2008, 105: 6998-7003.

Gibbs, D., Yang, Z., Constantine, R., **Ma, X.**, Camp, N.J., Yang, X., Chen, H., Jorgenson, A., et al. Further mapping of 10q26 supports strong association of HTRA1 polymorphisms with age-related macular degeneration. *Vision Research*, 2008, 48: 685-689.

Chen, H., Yang, Z., Gibbs, D., Yang, X., Hau, V., Zhao, P., **Ma, X.**, Zeng, J., Luo, L., et al. Association of HTRA1 polymorphism and bilaterality in advanced age-related macular degeneration. *Vision Research*, 2008, 48: 690-694

Luo, L., Harmon, J., Yang, X., Chen, H., Patel, S., Mineau, G., Yang, Z., Constantine, R., Buehler, J., Kaminoh, Y., **Ma, X.**, Wong, T.Y., Zhang, M., Zhang, K. Familial aggregation of age-related macular degeneration in the Utah population. *Vision Research*, 2008, 48: 494-500

Yang, X., Zabriskie, N.A., Hau, V.S., Chen, H., Tong, Z., Gibbs, D., Farhi, P., Katz, B.J., Luo, L., Pearson, E., Goldsmith, J., **Ma, X.**, Kaminoh, Y., Chen, Y., Yu, B., Zeng, J., Zhang, K., Yang, Z. Genetic association of LOXL1 gene variants and exfoliation glaucoma in a Utah cohort. *Cell Cycle*, 2008, 7: 521-524

Chen, G., **Ma, X.**, Meng, F., & Li, G. The electron transfer reactivity of kaempferol and its interaction with amino acid residues. *Bioelectrochemistry*, 2008, 72: 169-173.

Huang, J., Zhang, D., Xing, W., **Ma, X.**, Yin, Y., Wei, Q., & Li, G. An approach to assay calcineurin activity and the inhibitory effect of zinc ion. *Analytical Biochemistry*, 2007, 375: 385-387.

Chen, G., **Ma, X.**, Zhang, X., Huang, J., & Li, G. An electrochemical study of myoglobin entrapped in three kinds of films. *Sensors Letters*, 2007, 5: 463-466.

Ma, X., Sun, Z., Zheng, X., Li, G. Electrochemistry and electrocatalytic properties of heme proteins incorporated in lipopolysaccharide films. *Journal of Analytical Chemistry*, 2006, 61: 669-672.

Ma, X., Chen, T., Liu, L., & Li, G. Electrochemical studies on polysorbate-20 (Tween 20)-entrapped hemoglobin and its application in a hydrogen peroxide biosensor. *Biotechnology and Applied Biochemistry*, 2005, 41: 279-282.

Ma, X., Yang, R., & Li, G. Hydrogen peroxide biosensor based on the direct electrochemistry of myoglobin immobilized in poly-3-hydroxybutyrate film. *American Journal of Biochemistry and Biotechnology*, 2005, 1: 43-46.

Liu, X., Xu, Y., **Ma, X.**, & Li, G. A third-generation hydrogen peroxide biosensor fabricated with hemoglobin and Triton X-100. *Sensors and Actuators B: Chemical*, 2005, 106: 284-288.

Ma, X., Liu, X., Xiao, H., & Li, G. Direct electrochemistry and electrocatalysis of hemoglobin in poly-3-hydroxybutyrate membrane. *Biosensors and Bioelectronics*, 2005, 20: 1836-1842.

CONFERENCES AND PRESENTATIONS

“Tuning nucleation pathways through sequence-engineering of biomimetic polymers.” **Ma, X.**, Newcomb, C., Chen, C., De Yoreo, J. Peptoid Summit, Aug. 6-7, 2015, Berkeley, CA.

“Peptoid self-assembly shows a two-step nucleation process.” **Ma, X.**, Jiao, F., Chen, C., & De Yoreo, J. Materials Research Society, Apr. 6-10, 2015, San Francisco, CA.

“*In situ* AFM shows peptoid self-assembly follows a complex hierarchical pathway.” **Ma, X.**, Chen, C., & De Yoreo, J. Materials Research Society, Dec. 1-5, 2014, Boston, MA.

“Effects of ionic strength on mechanical responses of self-assembled hepatitis B virus-like particles.” **Ma, X.**, Li, H., & Dragnea, B. Gordon Research Conference on Physical Virology, Jan. 20-25, 2013, Ventura, CA.

“Elasticity mapping on single particles reveals mechanistic details of hepatitis B virus capsids.” **Ma, X.**, Li, H., & Dragnea, B. FASEB Science Research Conference on Virus Structure & Assembly, June 10-15, 2012, Saxtons River, VT.

TEACHING EXPERIENCE

Instructor: Aug. 2015-present

- General Chemistry
- General Chemistry Lab

Graduate Research Advisor: Oct. 2014-Aug. 2015

Pacific Northwest National Laboratory, Richland, WA

- Provided training of laboratory safety on chemistry and radiation
- Trained PhD students to use AFM instruments
- Mentored PhD students to design and conduct experiments

Undergrad Research Advisor: June 2011-Aug.2013

Indiana University, Bloomington, IN

- Recruited, trained and supervised undergraduate researchers
- Mentored undergraduate students on research projects
- Helped students to present their research
- Assisted students in applying undergraduate research awards to fund their projects

Nanoscale Characterization Facility Instructor: Jan. 2010-Oct.2013

Indiana University, Bloomington, IN

- Provided training of both Cypher and MFP-3D AFM instruments
- Provided training of SEM instrument
- Provided training of Sputter Coater and Thermal Evaporator instruments

Associate Instructor:

Aug. 2010-Dec.2011

Indiana University, Bloomington, IN

- Co-taught “Fundamentals of Materials”
- Co-taught “Methods for Biological and Environmental Chemical Analysis Laboratory”
- Led discussions, lectured in lab sessions and provided after-class tutoring
- Received “excellent” in 80% of student evaluations.
- Demonstrated strong communication and presentation skills by effectively delivering scientific lectures to students

RESEARCH INTERESTS

- *In situ* AFM, force spectroscopy, chemical nano-lithography
- Drug delivery systems based on self-assembled virus-like particles
- Novel bioinspired materials for biomedical and bioengineering applications
- Fabrication of ultrasensitive nano-scaled biosensors for the detection of disease biomarkers, and continuous monitoring of essential biomolecules *in vivo*

PROFESSIONAL SERVICE*Journal Reviewer:*

2013-present

- Analytical Chemistry
- ACS Applied Materials & Interfaces
- Biosensors and Bioelectronics
- Chemical Communication
- Physical Chemistry Chemical Physics
- Journal of Physical Chemistry B
- Journal of Biomedical Nanotechnology
- Electrochimica Acta
- Nanotechnology
- Molecular Biosystems
- Integrative Biology
- RSC Advances

Graduate Assistant:

Indiana University, Bloomington, IN

- Coordinated on a National Science Foundation (NSF) grant application, 2012
- Responsible for training and maintenance of AFM instruments at Indiana University Nanoscience Center, 2009-2013

AWARDS

- Peglow travel award, Indiana University Bloomington, 2012, 2013
- Graduate Fellowship, Indiana University Bloomington, 2008-2013
- BASF (Baden Aniline and Soda Factory) Fellowship, Nanjing University, 2005, 2006
- Outstanding Graduate Scholarship, Nanjing University, 2005