

PIOTR MAK

Department of Chemistry Saint Louis University

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Professional Preparation

Jagiellonian University	Krakow, Poland	Chemistry	M.Sc.	1999
Jagiellonian University	Krakow, Poland	Chemistry	Ph. D.	2004
Marquette University	Milwaukee, USA	Biophysics	postdoctoral	2008

Appointments

Associate Professor	Saint Louis University	2023 – present
Assistant Professor	Saint Louis University	2017 – 2023
Research Assistant Professor	Marquette University	2016 – 2017
Senior Research Associate	Marquette University	2009 – 2016

Research Interests

The overarching goal of our studies is to understand oxygen activation chemistry, which is a critical function of a wide variety of physiologically important heme proteins and their models, including those with potential biotechnological applications. These objectives are accomplished by the innovative combination of resonance Raman (rR) spectroscopy with cryoradiolysis methodology and nanodisc sampling technology and are often complemented by other spectroscopic (EPR, NMR), biophysical, biochemical, and computational methods.

Awards and recognition

1. SLU Faculty Career Award (2023)
2. NSF CAREER Award (2022)
3. ACS Petroleum Research Fund Award (2020)
4. Award for Excellence in Chemistry by the American Institute of Chemists (2014)
5. Postdoctoral Award for Excellence in Chemistry by the American Institute of Chemists (2008)

Grants, Scholarships and Fellowships

1. Title: Unraveling diverse mechanisms of heme degradation processes
Funding agency: NSF (CAREER Award)
Period of funding: 2022-07-01 to 2027-06-30
2. Title: Elucidating factors that control activation of alkanes by heme proteins
Funding agency: ACS Petroleum Research Fund
Period of funding: 2020-09-01 to 2022-08-31
3. Title: Mechanistic studies of Cytochromes P450 involved in *Mycobacterium tuberculosis* physiology
Funding agency: SLU President's Research Fund
Period of funding: 2020-05-01 to 2021-05-31

Publications (Google Scholar citations: 1143; h-index: 20)

41. Grote, D.; Thambyrajah, T.; Mak, P. J.

- "Insight into Structural Factors that Control Terminal-Alkane Hydroxylation by CYP153A6", *ChemBioChem*, **2025**, under revision.
40. Chiura, T.; Pham, M.; Baum, D. A.; Mak, P. J.
"Interactions between heme and DNA G-quadruplex involve the oxygen atom of guanine", *Inorg. Chem.*, **2025**, under revision.
 39. Chiura, T.; Mitchell, A. J.; Grote, D. L.; Khojandi, N.; Teague, R. M.; Mak, P. J.
"Interactions of azole-based inhibitors with human heme oxygenase". *J. Inorg. Biochem.*, **2023**, *244*, 112238 – 112248.
 38. Snyder, S. N.; Chiura, T.; Mak, P. J.
"Resonance Raman Characterization of O₂-Binding Heme Proteins", *Methods Mol. Biol.*, (Oxygen sensing), Springer Nature, Clifton, NJ; Weinert, E. E. Ed. **2023**, *2648*, 27-41.
 37. Snyder, N. S.; Mak, P. J.
"Structure-function characterization of the mono- and diheme forms of MhuD, a noncanonical heme oxygenase from *Mycobacterium tuberculosis*", *J. Biol. Chem.*, **2022**, *298*, 101475-101790.
 36. Chiura, T.; Mak, P. J.
"Investigation of Cyanide Ligand as an Active Site Probe of Human Heme Oxygenase", *Inorg. Chem.* **2021**, *60*, 4633-4645.
 35. Dybas, J.; Chiura, T.; Marzec, K. M.; Mak, P. J.
"Probing Heme Active Sites of Hemoglobin in Functional Red Blood Cells Using Resonance Raman Spectroscopy", *J. Phys. Chem. B* **2021**, *125*, 3556-3565.
 34. Traore, E. S.; Li, J.; Chiura, T.; Geng, J.; Sachla, A. J.; Yoshimoto, F.; Eichenbaum, Z.; Davis, I.; Mak, P. J.; Liu, A.
"Heme binding to HupZ with a C-terminal tag from group A streptococcus", *Molecules* **2021**, *26*, 549-568.
 33. Dybas, J.; Bokamper, M. J.; Marzec, K. M.; Mak, P. J.
"Probing the structure-function relationship of hemoglobin in living human erythrocytes". *Spectrochim. Acta Part A: Molecular and Biomolecular Spectroscopy*, **2020**, *239*, 118530-118537.
 32. Atifi, A.; Mak, P. J.; Ryan, M. D.
"Ion Pairing versus Solvation of Dinitrobenzene Anions in Room-Temperature Ionic Liquids (RTILs): Vibrational Signatures of RTIL-Substrate Interactions", *J. Phys. Chem. A*, **2020**, *124*, 10225-10238.
 31. Usai, R.; Kaluka, D.; Mak, P. K.; Liu, Y.; Kincaid, J. R.
"Resonance Raman spectroscopic studies of peroxo and hydroperoxo intermediates in lauric acid (LA)-bound cytochrome P450 119", *J. Inorg. Biochem.* **2020**, *208*, 111084-111091.
 30. Atifi, A.; Mak, P. J.; Ryan, M. D.
"Proton-Coupled Reduction of an Iron Nitrosyl Porphyrin in the Protic Ionic Liquid Nanodomain," *Electrochim. Acta*, **2019**, *295*, 735-741.
 29. Mak, P. J.; Duggal, R.; Denisov, I. G.; Gregory, M. C.; Sligar, S. G.; Kincaid, J. R.
"Human Cytochrome CYP17A1: The Structural Basis for Compromised Lyase Activity with 17-Hydroxyprogesterone", *J. Am. Chem. Soc.*, **2018**, *140*, 7324-7331.
 28. Mak, P. J.; Denisov, I. G.
"Spectroscopic studies of the cytochrome P450 reaction mechanisms", *Biochem. Biophys. Acta, Proteins and Proteomics*, **2018**, *1866*, 178-204.
 27. Gregory, M. C.; Mak, P. J.; Khatri, Y.; Kincaid, J. R.; Sligar, S. G.
"Human P450 CYP17A1: Control of Substrate Preference by Asparagine 202", *Biochemistry*, **2017**, *57*, 764-771.
 26. Mak, P. J.; Kincaid, J. R.

- "Bioinorganic Applications of Resonance Raman Spectroscopy" in Reedijk, J. (Ed.) *Elsevier Reference Module in Chemistry, Molecular Sciences and Chemical Engineering*. Waltham, MA; Elsevier, **2017**, pp 1-16.
25. Zhu, Q.; Mak, P. J.; Tuckey, R. C. ; Kincaid, J. R.
 "Active site structures of CYP11A1 in the presence of its physiological substrates and alterations upon binding of Adrenodoxin", *Biochemistry*, **2017**, 56, 5786-5797.
 24. Wang, Y.; Mak, P. J.; Zhu, Q.; Kincaid, J. R.
 "Application of resonance Raman spectroscopy for interrogation of cryoradiolytically reduced oxygenated heme proteins", *J. Raman Spectrosc.*, **2017**, 48, 180-190.
 23. Mak, P. J.
 "Resonance Raman spectroscopy as a structural probe of cytochrome P450 enzymatic cycle", *Handbook of Porphyrin Science*, Kadish, K. M.; Smith, K.; Guillard, R. Eds., World Scientific Publishing Co., Singapore, **2016**, 42, 1-120.
 22. Denisov, I.G.; Mak, P. J.; Grinkova, Y. V.; Sligar, S. G.; Kincaid, J. R.
 "The use of isomeric testosterone dimers to explore allosteric effects in substrate binding to cytochrome P450 CYP3A4", *J. Inorg. Biochem.* **2016**, 158, 77-85.
 21. Mak, P. J.; Gregory, M. C.; Denisov, I. G.; Sligar, S. G.; Kincaid, J. R.
 "Unveiling the crucial intermediates in androgen production", *Proc. Natl. Acad. Sci. USA* **2015**, 112, 15856-15861.
 20. Mak, P. J.; Thammawichai, W.; Wiedenhoeft, D.; Kincaid, J. R.
 "Resonance Raman spectroscopy reveals pH-dependent active site structural changes of Lactoperoxidase Compound 0 and its ferryl heme O-O bond cleavage products", *J. Am. Chem. Soc.* **2015**, 137, 349-361.
 19. Jones, E. M.; Monza, E.; Balakrishnan, G.; Blouin, G. C.; Mak, P. J.; Zhu, Q.; Kincaid, J. R.; Guallar, V.; Spiro, T. G.
 "Differential Control of Heme Reactivity in Alpha and Beta Subunits of Hemoglobin: A Combined Raman Spectroscopic and Computational Study", *J. Am. Chem. Soc.* **2014**, 136, 10325-10339.
 18. Mak, P. J.; Luthra, A.; Sligar, S. G.; Kincaid, J. R.
 "Resonance Raman spectroscopy of the oxygenated intermediates of CYP19 implicates a Compound I intermediate in the final lyase step", *J. Am. Chem. Soc.* **2014**, 136, 4825-4828.
 17. Rwere, F.; Mak, P. J.; Kincaid, J. R.
 "Resonance Raman determination of vinyl group orientations in different forms of myoglobins", *J. Raman Spectrosc.*, **2014**, 45, 97-104.
 16. Mak, P. J.; Gregory, M. C.; Sligar, S. G.; Kincaid, J. R.
 "Resonance Raman spectroscopy reveals that substrate structure selectively impacts the heme-bound diatomic ligands of CYP17", *Biochemistry*, **2014**, 53, 90-100.
 15. Mak, P. J.; Zhu, Q.; Kincaid, J. R.
 "Using resonance Raman cross-section data to estimate the spin state populations of Cytochromes P450", *J. Raman Spectrosc.* **2013**, 44, 1792-1794.
 14. Gregory, M.; Mak, P. J.; Sligar, S. G.; Kincaid, J. R.
 "Differential Hydrogen Bonding in Human CYP17 Dictates Hydroxylation versus Lyase Chemistry", *Angew. Chem. Int. Ed.*, **2013**, 52, 5342-5345.
 13. Mak, P. J.; Yang, Y.; Im, S.-C.; Waskell, L. A.; Kincaid, J. R.
 "Experimental Documentation of the Structural Consequences of Hydrogen-Bonding Interactions to the Proximal Cysteine of a Cytochrome P450", *Angew. Chem. Int. Ed.*, **2012**, 51, 10403-10407.
 12. Mak, P. J.; Denisov, I.G.; Grinkova, Y. V.; Sligar, S. G.; Kincaid, J. R.
 "Defining CYP3A4 Structural Responses to Substrate Binding. Raman Spectroscopic Studies of a Nanodisc-Incorporated Mammalian Cytochrome P450", *J. Am. Chem. Soc.*, **2011**, 133, 1357-1366.

11. Mak, P. J.; Zhang, H.; Hollenberg, P. F.; Kincaid, J. R.
"Defining the Structural Consequences of Mechanism-Based Inactivation of Mammalian Cytochrome P450 2B4 Using Resonance Raman Spectroscopy", *J. Am. Chem. Soc.* **2010**, *132*, 1494-1495.
10. Balakrishnan, G.; Ibrahim, M.; Mak, P. J.; Hata, J.; Kincaid, J. R.; Spiro, T. G.
"Linking Conformation Change to Hemoglobin Activation Via Chain-Selective Time-resolved Resonance Raman Spectroscopy of Protoheme/Mesoheme Hybrids" *J. Biol. Inorg. Chem.*, **2009**, *14*, 741-750.
9. Mak, P. J.; Kincaid, J. R.
"Resonance Raman spectroscopic studies of hydroperoxo derivatives of cobalt-substituted myoglobin." *J. Inorg. Biochem.*, **2008**, *102*, 1952-1957.
8. Denisov, I. G.; Mak, P. J.; Makris, T. M.; Sligar, S. G.; Kincaid, J. R.
"Resonance Raman Characterization of the Peroxo and Hydroperoxo Intermediates in Cytochrome P450." *J. Phys. Chem. A*, **2008**, *112*, 13172-13179.
7. Mak P. J.; Kaluka D.; Manyumwa E. M.; Zhang H.; Deng T.; Kincaid J. R.
"Defining Resonance Raman Spectral Response to Substrate Binding by Cytochrome P450." *Biopolymers*, **2008**, *89*, 1045-1053.
6. Rwere, F.; Mak, P. J.; Kincaid, J. R.
"Resonance Raman Interrogation of the Consequences of Heme Rotational Disorder in Myoglobin and Its Ligated Derivatives." *Biochemistry*, **2008**, *47*, 12869-12877.
5. Mak, P. J.; Im, S.-C.; Zhang, H.; Waskell, L. A.; Kincaid, J. R.
"Resonance Raman Studies of Cytochrome P450 2B4 in Its Interactions with Substrates and Redox Partners." *Biochemistry*, **2008**, *47*, 3950-3963.
4. Rwere F.; Mak P. J.; Kincaid J. R.
"The impact of altered protein-heme interactions on the resonance Raman spectra of heme proteins. Studies of heme rotational disorder." *Biopolymers*, **2008**, *89*, 179-186.
3. Mak, P. J.; Denisov, I. G.; Victoria, D.; Makris, T. M.; Deng, T.; Sligar, S. G.; Kincaid, J. R.
"Resonance Raman Detection of the Hydroperoxo Intermediate in the Cytochrome P450 Enzymatic Cycle." *J. Am. Chem. Soc.*, **2007**, *129*, 6382-6383.
2. Podstawka, E.; Mak, P. J.; Kincaid, J. R.; Proniewicz, L. M.
"Low frequency resonance Raman spectra of isolated α and β subunits of hemoglobin and their deuterated analogues." *Biopolymers*, **2006**, *83*, 455-466.
1. Mak, P. J.; Podstawka, E.; Kincaid, J. R.; Proniewicz, L. M.
"Effects of systematic peripheral group deuteration on the low-frequency resonance Raman spectra of myoglobin derivatives." *Biopolymers*, **2004**, *75*, 217-228.

Invited Talks and Other Presentations (invited talks are indicated by asterisks)

28. 21st International Conference on Biological Inorganic Chemistry,* Long Beach, CA, USA, 2025
27. Georgian Bay International Conference on Bioinorganic Chemistry,* Ontario, Canada, 2025
26. Department of Chemistry,* University of Florence, Florence, Italy, 2025
25. Department of Chemistry,* Aix-Marseille University, Marseille, France, 2025
24. Faculty of Biochemistry,* Biophysics and Biotechnology, Jagiellonian University, Krakow, Poland, 2025
23. Faculty of Chemistry,* Jagiellonian University, Krakow, Poland, 2025
22. Physical Science Department,* Truman State University, Kirksville, MO, USA, 2025
21. Department of Chemistry,* University of Louisville, Louisville, KY, USA, 2025
20. International Conference on Porphyrins and Phthalocyanines,* Buffalo, NY, USA, 2024
19. Chemistry Department,* Marquette University, Milwaukee, WI, 2023
18. ACS Midwest-Great Lakes Regional Meeting,* St. Louis, MO, 2023.
17. International Conference on Advanced Vibrational Spectroscopy,* Krakow, Poland, 2023

16. *Georgian Bay International Conference on Bioinorganic Chemistry*,* Ontario, Canada, 2023
15. Department of Chemistry and Biochemistry,* Florida International University, Miami, 2022
14. *International Conference on Cytochrome P450*,* Washington, D.C., USA, 2022
13. *International Conference on Raman Spectroscopy*, Long Beach, CA, 2022
12. *International Conference on Porphyrins and Phthalocyanines*,* Barcelona, Spain, 2022
11. Department of Chemistry and Biochemistry,* University of Missouri – St. Louis, 2022
10. Department of Chemistry,* North Carolina State University, 2022
9. *ACS Midwest Regional Meeting*, Springfield, MO, 2021
8. *International Conference on Advanced Vibrational Spectroscopy*,* Krakow, Poland, 2021
7. *International Conference on Porphyrins and Phthalocyanines*,* Buffalo, NY, USA, 2021
6. Department of Chemistry & Physics,* Southeast Missouri State University, 2021
5. *Georgian Bay International Conference on Bioinorganic Chemistry*,* Ontario, Canada, 2019
4. Chemistry Department,* Missouri State University, 2019
3. Department of Biochemistry and Molecular Biology,* Saint Louis University 2019
2. *International Conference on Porphyrins and Phthalocyanines*, Munich, Germany, 2018
1. Chemistry Department*, Saint Louis Community College, 2017