

# Thomas Michael Makris

University of South Carolina  
Department of Chemistry and Biochemistry  
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## Department Profile:

[http://sc.edu/study/colleges\\_schools/chemistry\\_and\\_biochemistry/our\\_people/makris\\_thomas.php](http://sc.edu/study/colleges_schools/chemistry_and_biochemistry/our_people/makris_thomas.php)

**Laboratory Website:** <http://makrislab.com>

## **EDUCATION and TRAINING**

2006 – 2012	Research Associate	Biochemistry, Molecular Biology and Biophysics University of Minnesota, Minneapolis, MN Advisor: John D. Lipscomb
2004 – 2006	Postdoctoral Fellow	Biochemistry University of Illinois Urbana-Champaign Advisor: Stephen G. Sligar
2004	PhD in Biophysics	Center for Biophysics and Computational Biology University of Illinois Urbana-Champaign Advisor: Stephen G. Sligar
1996	Bachelors in Arts	Department of Biology, Biochemistry Concentration University of Pennsylvania Thesis Advisor: Fevzi Daldal

## **PROFESSIONAL APPOINTMENTS**

2012-	Assistant Professor	Department of Chemistry and Biochemistry University of South Carolina, Columbia, SC
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## **AWARDS and MEMBERSHIPS**

NSF Career Award  
Teachers listed as outstanding by their students, 2001 & 2002  
Biochemistry Teaching Assistant Award, Spring, 2002  
Graduation with Distinction in Biology, 1996  
2009-present, American Chemical Society  
2016-present, American Society of Biochemistry and Molecular Biology

## **PUBLICATIONS (in reverse chronological order)**

\* T. Makris as corresponding author; graduate/undergraduate students in Makris laboratory are underlined

(as an assistant professor at USC)

*published / in press*

\*36. Hsieh, C. H., Huang, X., Amaya, J. A., Rutland, C.D., Keys, C. L., Groves, J. T., Austin, R. N., and **Makris, T. M**  
(submitted) The Enigmatic P450 Decarboxylase OleT is Capable of, but Evolved to Frustrate Oxygen  
Rebound, *Biochemistry*, accepted

35. DeHaven, B. A., Tokarski, J. T., Korous, A. A., Mentink-Vigier, F., **Makris, T. M.**, Brugh, A. M., Forbes, M. D. E., van Tol, J., Bowers, C. R., and Shimizu, L. S. (2017) Persistent Radicals of Self-assembled Benzophenone bis-urea Macrocycles: Characterization and Application as a Polarizing Agent for Solid-state DNP MAS Spectroscopy, *Chemistry-Eur. J.*, in press
- \*34. Wise, C. E., and **Makris, T. M.** (2017) Recruitment and Regulation of the Non-ribosomal Peptide Synthetase Modifying Cytochrome P450 Involved in Nikkomycin Biosynthesis, *ACS Chem Biol.*, in press
- \*33. Wise, C. E., Grant, J. L., Amaya, J. A., Ratigan, S. C., Hsieh, C. H., Manley, O. M., and **Makris, T. M.** (2017) Divergent mechanisms of iron-containing enzymes for hydrocarbon biosynthesis, *J Biol Inorg Chem* 22, 221-235.
- \*32. Grant, J. L., Mitchell, M. E., and **Makris, T. M.** (2016) Catalytic strategy for carbon-carbon bond scission by the cytochrome P450 OleT, *Proc. Nat. Acad. Sci. USA* 113, 10049-10054.
- \*31. Hsieh, C. H., and **Makris, T. M.** (2016) Expanding the substrate scope and reactivity of cytochrome P450 OleT, *Biochem Biophys Res Commun* 476, 462-466.
- \*30. Amaya, J. A., Rutland, C. D., and **Makris, T. M.** (2016) Mixed regiospecificity compromises alkene synthesis by a cytochrome P450 peroxygenase from *Methylobacterium populi*, *J. Inorg. Biochem.* 158, 11-16.
- \*29. Grant, J. L., Hsieh, C. H., and **Makris, T. M.** (2015) Decarboxylation of fatty acids to terminal alkenes by cytochrome P450 compound I, *J. Am. Chem. Soc.* 137, 4940-4943.
28. Abeyasinghe, D., Gerke, B., Morrison, G., Hsieh, C. H., Smith, M. D., Pottgen, R., **Makris, T. M.**, and zur Loye, H. C. (2015) Synthesis, characterization, and properties of reduced europium molybdates and tungstates, *J. Solid State Chem.* 229, 173-180.
27. **Makris, T. M.**, Vu, V. V., Meier, K. K., Komor, A. J., Rivard, B. S., Munck, E., Que, L., Jr., and Lipscomb, J. D. (2015) An unusual peroxo intermediate of the arylamine oxygenase of the chloramphenicol biosynthetic pathway, *J. Am. Chem. Soc.* 137, 1608-1617.
26. Knoot, C. J., **Makris, T. M.**, and Lipscomb, J. D. (2015) Dinuclear Iron Cluster-Containing Oxygenase CmlA, *Encyclopedia of Inorganic and Bioinorganic Chemistry*. DOI: 10.1002/9781119951438.eibc232
25. Su, S., Panmanee, W., Wilson, J. J., Mahtani, H. K., Li, Q., Vanderwielen, B. D., **Makris, T. M.**, Rogers, M., McDaniel, C., Lipscomb, J. D., Irvin, R. T., Schurr, M. J., Lancaster, J. R., Jr., Kovall, R. A., and Hassett, D. J. (2014) Catalase (KatA) plays a role in protection against anaerobic nitric oxide in *Pseudomonas aeruginosa*, *PLoS One* 9, e91813.
24. **Makris, T. M.**, Knoot, C. J., Wilmot, C. M., and Lipscomb, J. D. (2013) Structure of a dinuclear iron cluster-containing beta-hydroxylase active in antibiotic biosynthesis, *Biochemistry* 52, 6662-6671.
23. Aukema, K. G., **Makris, T. M.**, Stoian, S. A., Richman, J. E., Munck, E., Lipscomb, J. D., and Wackett, L. P. (2013) Cyanobacterial aldehyde deformylase oxygenation of aldehydes yields n-1 aldehydes and alcohols in addition to alkanes, *ACS Catal* 3, 2228-2238.

(prior to appointment at USC)

22. Thompson, J. W., Salahudeen, A. A., Chollangi, S., Ruiz, J. C., Brautigam, C. A., **Makris, T. M.**, Lipscomb, J. D., Tomchick, D. R., and Bruick, R. K. (2012) Structural and molecular characterization of iron-sensing hemerythrin-like domain within F-box and leucine-rich repeat protein 5 (FBXL5), *J. Biol. Chem.* **287**, 7357-7365.
21. Vu, V. V., **Makris, T. M.**, Lipscomb, J. D., and Que, L., Jr. (2011) Active-site structure of a beta-hydroxylase in antibiotic biosynthesis, *J. Am. Chem. Soc.* **133**, 6938-6941.
20. **Makris, T. M.**, Chakrabarti, M., Munck, E., and Lipscomb, J. D. (2010) A family of diiron monooxygenases catalyzing amino acid beta-hydroxylation in antibiotic biosynthesis, *Proc Natl Acad Sci U S A* **107**, 15391-15396.
19. Denisov, I. G., Mak, P. J., **Makris, T. M.**, Sligar, S. G., and Kincaid, J. R. (2008) Resonance Raman characterization of the peroxo and hydroperoxo intermediates in cytochrome P450, *J. Phys. Chem. A* **112**, 13172-13179.
18. **Makris, T. M.**, von Koenig, K., Schlichting, I., and Sligar, S. G. (2007) Alteration of P450 distal pocket solvent leads to impaired proton delivery and changes in heme geometry, *Biochemistry* **46**, 14129-14140.
17. Mak, P. J., Denisov, I. G., Victoria, D., **Makris, T. M.**, Deng, T., Sligar, S. G., and Kincaid, J. R. (2007) Resonance Raman detection of the hydroperoxo intermediate in the cytochrome P450 enzymatic cycle, *J. Am. Chem. Soc.* **129**, 6382-6383.
16. Newcomb, M., Zhang, R., Chandrasena, R. E., Halgrimson, J. A., Horner, J. H., **Makris, T. M.**, and Sligar, S. G. (2006) Cytochrome p450 compound I, *J. Am. Chem. Soc.* **128**, 4580-4581.
15. **Makris, T. M.**, von Koenig, K., Schlichting, I., and Sligar, S. G. (2006) The status of high-valent metal oxo complexes in the P450 cytochromes, *J. Inorg. Biochem.* **100**, 507-518.
14. Sono, M., Perera, R., Jin, S., **Makris, T. M.**, Sligar, S. G., Bryson, T. A., and Dawson, J. H. (2005) The influence of substrate on the spectral properties of oxyferrous wild-type and T252A cytochrome P450-CAM, *Arch. Biochem. Biophys.* **436**, 40-49.
13. Sligar, S. G., **Makris, T. M.**, and Denisov, I. G. (2005) Thirty years of microbial P450 monooxygenase research: peroxo-heme intermediates--the central bus station in heme oxygenase catalysis, *Biochem. Biophys. Res. Commun.* **338**, 346-354.
12. Ke, N., Baudry, J., **Makris, T. M.**, Schuler, M. A., and Sligar, S. G. (2005) A retinoic acid binding cytochrome P450: CYP120A1 from *Synechocystis* sp. PCC 6803, *Arch. Biochem. Biophys.* **436**, 110-120.
11. Denisov, I. G., **Makris, T. M.**, Sligar, S. G., and Schlichting, I. (2005) Structure and chemistry of cytochrome P450, *Chem. Rev.* **105**, 2253-2277.
10. **Makris, T. M.**, Denisov, I. G., and Sligar, S. G. (2003) Haem-oxygen reactive intermediates: catalysis by the two-step, *Biochem. Soc. Trans.* **31**, 516-519.

9. Jin, S., **Makris, T. M.**, Bryson, T. A., Sligar, S. G., and Dawson, J. H. (2003) Epoxidation of olefins by hydroperoxo-ferric cytochrome P450, *J. Am. Chem. Soc.* **125**, 3406-3407.
8. Ibrahim, M., Denisov, I. G., **Makris, T. M.**, Kincaid, J. R., and Sligar, S. G. (2003) Resonance Raman spectroscopic studies of hydroperoxo-myoglobin at cryogenic temperatures, *J. Am. Chem. Soc.* **125**, 13714-13718.
7. **Makris, T. M.**, Davydov, R., Denisov, I. G., Hoffman, B. M., and Sligar, S. G. (2002) Mechanistic enzymology of oxygen activation by the cytochromes P450, *Drug Metab. Rev.* **34**, 691-708.
6. Denisov, I. G., **Makris, T. M.**, and Sligar, S. G. (2002) Formation and decay of hydroperoxo-ferric heme complex in horseradish peroxidase studied by cryoradiolysis, *J. Biol. Chem.* **277**, 42706-42710.
5. Denisov, I. G., **Makris, T. M.**, and Sligar, S. G. (2002) Cryoradiolysis for the study of P450 reaction intermediates, *Methods Enzymol.* **357**, 103-115.
4. Denisov, I. G., **Makris, T. M.**, and Sligar, S. G. (2001) Cryotrapped reaction intermediates of cytochrome p450 studied by radiolytic reduction with phosphorus-32, *J. Biol. Chem.* **276**, 11648-11652.
3. Davydov, R., **Makris, T. M.**, Kofman, V., Werst, D. E., Sligar, S. G., and Hoffman, B. M. (2001) Hydroxylation of camphor by reduced oxy-cytochrome P450cam: mechanistic implications of EPR and ENDOR studies of catalytic intermediates in native and mutant enzymes, *J. Am. Chem. Soc.* **123**, 1403-1415.
2. Davydov, R., Macdonald, I. D. G., **Makris, T. M.**, Sligar, S. G., and Hoffman, B. M. (1999) EPR and ENDOR of catalytic intermediates in cryoreduced native and mutant oxy-cytochromes P450cam: Mutation-induced changes in the proton delivery system, *J. Am. Chem. Soc.* **121**, 10654-10655.

### **Book Chapter**

1. **Makris, T. M.**, Denisov, I. G., Schlichting, I., and Sligar, S. G. In *Cytochrome P450: Structure, Mechanism and Biochemistry*, P. R. O. DeMontellano, ed. (New York, Plenum), pp. 149-182.

### **RESEARCH SUPPORT**

#### **(current)**

"CAREER: Mechanism of Cytochrome P450 Alkene Biosynthesis" National Science Foundation, Chemistry of Life Processes. 05/01/16 04/30/2021, \$695,879, PI

"Dioxygen-Dependent Mechanisms of Carbon-Carbon Bond Cleavage" Office of the VPR, USC, Aspire I program, 7/1/17 – 06/30/18, \$15,000 (PI)

"Acquisition of Isothermal Titration Calorimeter for Biochemistry and Nanoscience Research Development" Office of the VPR USC, Aspire III program, 7/1/17 – 06/30/18, \$100,000 (co-PI with Prof. A. Greytak)

"Center for Chemical Innovation (CCI) for Multi-Enzyme Assemblies for Efficient Catalysis." Office of the VPR USC, Aspire II program, 7/1/17 – 06/30/18, \$100,000 (co-PI with Q. Wang and G. Wang)

"Access to the 3rd generation synchrotron X-ray source through SER-CAT at the Advanced Photon Source" Office of the Vice President of Research, USC. 07/01/16-09/30/2017, \$27,000 (co-PI with Prof. M. Chruszcz)

(completed)

"Acquisition of Applied Photophysics Stopped Flow Spectrometer" Office of the Vice President of Research, USC. 05/16/13 – 08/15/14 \$45,000, PI

"Access to the 3rd generation synchrotron X-ray source through SER-CAT at the Advanced Photon Source" Office of the Vice President of Research, USC. 05/15/2014-12/30/2015, \$27,000, co-PI with Profs. M. Chruszcz and L. Lebioda

**(support for conferences)**

2016 SouthEast Regional ACS Meeting (SERMACS), Division of Biological Chemistry, ACS, \$750

**(support to graduate research and travel)**

- SPARC Graduate research grant, Chun H. Hsieh, "Leveraging P450 Enzymes for Renewable Bioenergy Production" 5/1/16-5/1/17, \$4,968
- Travel awards to J. L. Grant, C.E. Wise, and J.A. Amaya to attend Enzyme Mechanisms-25, 1/17, \$1500 total
- Travel award to J. L. Grant to attend CanBic 15, 5/15

**(support to undergraduate research)**

1. Magellan Scholar Program, Nicholas Leschinsky and Julia Bian, "Structural and functional studies of Cytochrome P450 (CYP152) enzymes towards Sustainable Biofuels" 5/1/17 – 4/30/18, \$5,000
2. Magellan Scholar Program, Aubrey Brockmiller, "Porphyrin Heme Substitution in Escherichia coli for NRPS Mechanisms" 1/1/16-07/1/16, \$3,000
3. Magellan Scholar Program, Cooper D. Rutland, "Enzymatic activities of P450 BSbeta mutagenic forms for Biofuel applications" 1/1/16-07/1/16, \$3,000
4. Science Undergraduate Research Fellowship, Julia Bian, "P450 Oxygenase:Decarboxylase Boundaries" 12/15/15-06/30/16, \$3000
5. Science Undergraduate Research Fellowship, Himabindu Vinnakota, "Biosynthesis and Tailoring of Antibiotics in Bacteria" 06/01/15-06/30/16, \$3000
6. Science Undergraduate Research Fellowship, Megan E. Mitchell, "in vivo Production of Hydrocarbons for Fuels" 07/01/15-12/30/15, \$1500
7. Magellan Scholar Program, Megan E. Mitchell, "MGS: in vivo Production of Alkenes as Biofuels by a Novel Cytochrome P450" 01/01/15-12/31/15, \$3000
8. Science Undergraduate Research Fellowship, Megan E. Mitchell, "Biosynthesis of Hydrocarbons" 07/01/13-06/30/14, \$3000

9. Magellan Scholar Program, Job L. Grant "MGS: Investigation of P450 Enzymes for Use in Biofuel Synthesis"  
01/01/13-12/31/13, \$2400

**Selected Conferences and Invited Seminars (\*: scheduled)**  
**(as an Assistant Professor at USC)**

- \*16. Department of Chemistry, Carnegie Mellon University, September 21, 2017
- \*15. 6<sup>th</sup> Georgian Bay International Conference on Bioinorganic Chemistry (CanBic), Parry Sound, ON, Canada, July 2017
- 14. University of Illinois Urbana-Champaign, Department of Chemistry, Urbana, IL, "Harnessing unusual metalloenzyme reactivity for advanced biofuel synthesis" October 27, 2016\*
- 13. SouthEast Regional American Chemical Society (SERMACS), Columbia, SC, "Tuning P450 metal-oxo reactivity for the biosynthesis of fungible fuels" October 24, 2016\*
- 12. Emory University, Department of Chemistry, Atlanta, GA, "Harnessing unusual metalloenzyme reactivity for advanced biofuel synthesis" October 5, 2016
- 11. University of Minnesota, Department of Biochemistry, Molecular Biology, and Biophysics, Minneapolis, MN "Harnessing unusual metalloenzyme reactivity for advanced biofuel synthesis" September 21, 2016
- 10. 13<sup>th</sup> International Symposium on Cytochrome P450, Vancouver, Canada "Two roads diverge: Harnessing P450 iron-oxo reactivity for hydrocarbon synthesis" July 24, 2016
- 9. Francis Marion University, "Enzymatic Synthesis of Hydrocarbons for Advanced Biofuel Production" November 12, 2015
- 8. Pacifichem 2015, Honolulu, Hawaii, "Rerouting of cytochrome P450 ferryl intermediates for hydrocarbon biosynthesis" December 17, 2015
- 7. 5<sup>th</sup> Georgian Bay International Conference on Bioinorganic Chemistry (CanBic), Parry Sound, ON, Canada, "Carbon-Carbon Bond Scission by Cytochrome P450 Compound I" May 21, 2015
- 6. South Carolina Section, American Chemical Society, Coastal Carolina Univ., Conway, SC "Reprogramming of Monooxygenase Enzymes for Carbon-Carbon Bond Cleavage" March 6, 2015
- 5. Metalloprotein Interest Group, University of Minnesota, Minneapolis, MN, "Carbon-Carbon Cleavage by Cytochrome P450 OleTJE" December 5, 2014
- 4. Department of Chemistry and Biochemistry, University of South Carolina, Columbia SC, "Harnessing Metalloenzyme Catalysis for the Biosynthesis of Novel Antibiotics and Biofuels" October 31, 2014
- 3. 12<sup>th</sup> International Symposium on Cytochrome P450, Kyoto, Japan, "Kinetics and Mechanism of the Fatty Acid Decarboxylase OleTJE" September 26, 2014
- 2. Winthrop University, Department of Chemistry, Rock Hill, SC, "Metalloenzymes for the Biosynthesis of Novel Antibiotics and Biofuels" July 2, 2014
- 1. ACS Preparing for Life after Graduate School, Columbia, SC, "The Academic Job Search" June 5, 2013

**Other Presentations as an Assistant Professor**

25<sup>th</sup> Enzymes Mechanisms Conference, 2017 (St. Pete Beach, USA), Poster  
Gordon Research Conference on Metals in Biology, 2015 (Ventura, USA), Poster

**(Prior to USC)**

- Gordon Research Conference on Metals in Biology, 2010 (Ventura, USA), Poster
- 29<sup>th</sup> Midwest Enzyme Chemistry Conference, Chicago, IL, "A Novel Diiron Enzyme Involved in Antibiotic Biosynthesis" October, 2009
- 14<sup>th</sup> International Conference of Biological Inorganic Chemistry, Nagoya, Japan, "Spectroscopic and Functional Characterization of Diiron Monooxygenases Involved in Antibiotic Biosynthesis" July, 2009, invited talk
- International Conference on the Cytochromes P450, 2005 (Dallas, USA), Poster
- Gordon Research Conference on Metals in Biology, 2005 (Ventura, USA), Poster

- 13th International Conference on the Cytochromes P450, 2003 (Prague, Czech Republic), Poster
- COE Conference of IMS, 2002 (Okazaki, JP), Poster
- 6th International Conference on P450 Biodiversity and Biotechnology, Los Angeles, CA, August 2002, invited talk
- COE Conference of IMS, 2002 (Okazaki, JP), Poster
- 12th International Conference on the Cytochromes P450, June 2001 (La Grande Motte, France), Poster

## **PROFESSIONAL ACTIVITIES**

### **Session chair:**

January 2017      Session Chair, 25<sup>th</sup> Enzymes Mechanisms Meeting, St. Pete Beach, FL

### **Conference Organizer:**

October 2016      Session organizer, Catalysis and Biocatalysis session of the SouthEast Regional American Chemical Society Meeting, Columbia, SC

### **Grant Reviews/Panels:**

March 2017      National Science Foundation, Panel  
 February 2016      Reviewer for the Aspire Grant Program, Office of the VPR, USC, Aspire I, track 2  
 March 2014      Reviewer for the Aspire Grant Program, Office of the VPR, USC, Aspire II  
 March 2014      Reviewer for the SPARC Graduate Fellowship Program, USC  
 February 2014      *ad hoc* reviewer for the National Science Foundation

### **Journal Referee**

ACS Catalysis	Cellular and Molecular Life Sciences	FEBS Letters
J. Am. Chem. Soc.	J. of Biol. Inorg. Chem.	J. of Inorg. Biochem.
J. of Organometallic Chem.	Molecular Micro. and Biotech.	Nature Scientific Reports
Protein Science		

### **Departmental Committees**

Graduate Admissions      2013-2016  
 Library Committee      2013-present  
 Mass Spectrometry Committee      2015-present  
 GSRC Water Purification *ad hoc*      2015-present  
 Served on 19 Dissertation Committees in Chem and Biochem (chair of 12)  
 Served on 2 Dissertation Committees in Biological Sciences

## **TEACHING EXPERIENCE**

### **Lecture Courses**

CHEM 545      Physical Biochemistry, Spring 2016, Spring 2017  
 CHEM 759, CHEM719      Special Topics in Biochemistry (Bioinorganic Chemistry), Spring 2013, Spring 2014, Spring 2015  
 CHEM 751      Biosynthesis of Macromolecules Fall 2013, Fall 2014, Fall 2015

### **Seminar Courses**

CHEM 360      Undergraduate Seminar, Fall 2015, Fall 2016

**Research Courses**

CHEM 496,497	Undergraduate Research	CHEM 790, 791	Introduction to Research
CHEM 798	Research in Chemistry I	CHEM 799	Thesis Preparation
CHEM 898	Research in Chemistry II	CHEM 899	Dissertation Preparation

**RESEARCH GROUP**

Total PhD graduate students mentored:	6	(5 current)
PhD student coadvisor	1	(1 current)
Total B.S. undergraduate students mentored	19	(5 current)
Total High-school students mentored	2	

**Ph.D. Dissertations Supervised**

2016 Chun H. Hsieh Mechanistic Investigation and Potential Application of a Fatty Acid Decarboxylating Cytochrome P450 Peroxygenase