UNIVERSITY OF PENNSYLVANIA - PERELMAN SCHOOL OF MEDICINE
UNIVERSITY OF PENNSYLVANIA - SCHOOL OF ARTS AND SCIENCES

Curriculum Vitae

Date: 12/2022

Sergei Vinogradov, PhD

Address: 1013 Stellar-Chance Bldg.
422 Curie Blvd.
Philadelphia, PA 19104-6059 USA

If you are not a U.S. citizen or holder of a permanent visa, please indicate the type of visa you have:
none (U.S. citizen)

Education:

1988	M.S.	Moscow State University (Chemistry)
1995	Ph.D.	Moscow State University (Organic Chemistry)

Postgraduate Training and Fellowship Appointments:

1995-1997	Postdoc, Dept. of Biochemistry and Biophysics, Univ. of Pennsylvania
1999	Visiting Researcher, Biochemistry/Biophysics, Department of Biochemistry, University of Lund, Sweden

Military Service:

[none]

Faculty Appointments:

1998	Research Associate, University of Pennsylvania
1999-2005	Research Assistant Professor of Biochemistry and Biophysics, University of Pennsylvania School of Medicine
2005-2008	Research Associate Professor of Biochemistry and Biophysics, University of Pennsylvania School of Medicine
2008-2017	Associate Professor of Biochemistry and Biophysics, University of Pennsylvania School of Medicine
2017-present	Professor of Biochemistry and Biophysics, University of Pennsylvania School of Medicine (primary)
2017-present	Professor of Chemistry, University of Pennsylvania School of Arts and Sciences (secondary)

Other Appointments:

2009-present	Member, PENN Institute for Translational Medicine (ITMAT)
2011-present	Member, Abramson Family Cancer Center
2011-present	Member, PENN NanoBio Interface Center
2012	Grant Proposal Reviewer, Penn Neuroscience Center (CNC)
2015-present	Member, University of Pennsylvania, Bioengineering

	Graduate Group
2015-2019	Director and Principal Investigator, High Impact Neuroscience Research Resource Center "Enabling High-Resolution Microscopy of Oxygen in the Brain", funded by NINDS grant in 2015
2019-present	Director and Principal Investigator, Research Resource Center "Oxygen Imaging by Phosphorescence Quenching", funded by NIBIB grant in 2019

Memberships in Professional and Scientific Societies and Other Professional Activities:

International:

1995-Present	International Society of Oxygen Transport to Tissue
2000-Present	International Society of Porphyrins and Phthalocyanines
2018-Present	Interamerican Photochemical Society

National:

1995-Present	American Chemical Society
2006-Present	Optical Society of America
2007-Present	Electrochemical Society
2007-2010	Member of the PENN division of the NIH NTROI (Network for Translational Research in Optical Imaging)

Local:

2008-Present	Advisory Board for the University of Pennsylvania's NIH P41 Resource Center: "Ultrafast Optical Process Laboratory"

Academic and Institutional Committees:

2011-Present	Member, Biochemistry and Biophysics Graduate Group Admissions Committee
2011-Present	Member, Biochemistry and Biophysics Graduate Group Student Advising Committee
2018	University of Pennsylvania Review Committee for the Department of Neuroscience

Major Academic and Clinical Teaching Responsibilities:

2010-Present	University of Pennsylvania, Perelman School of Medicine, Biochemistry-Intermediary Metabolism course for 1st Year medical students
2010-Present	University of Pennsylvania, Graduate Group in Biochemistry and Molecular Biophysics (BMB), Department of Biochemistry and

		Biophysics, Optical Spectroscopy course (as a part of BMB 509).
	2007-2012	University of Pennsylvania, Graduate Group in Biochemistry and Molecular Biophysics (BMB), Department of Biochemistry and Biophysics, Optical Imaging overview (as a part of BMB 509).
	2008	University of Pennsylvania, Graduate Group in Biochemistry and Molecular Biophysics (BMB), Department of Biochemistry and Biophysics, Seminar Course - methods in biomedical imaging.
	2013	University of Pennsylvania, Department of Chemistry, Lectures on Chemical Kinetics (as a part of Chem455).
	2018	University of Pennsylvania, Department of Chemistry, Lectures on Photophysics (as a part of Chem558).
	2018-2020	University of Pennsylvania, Department of Chemistry, Lectures on Photochemistry/Photophysics (as a part of Chem558).
	2019 (spring)	University of Pennsylvania, Graduate Group in Biochemistry and Molecular Biophysics (BMB), Department of Biochemistry and Biophysics, co-taught Candidacy Exam Prep class (BMB 705).

Advisor to the following students and postdoctoral fellows:

	2001-2003	Postdoctoral advisor, Dr. Vladimir Rozhkov, Present position: Senior Researcher, Institute of Organic Chemistry, Kiev, Ukraine
	2001-2003	Postdoctoral advisor, Dr. Ivo Rietveld, Present position: Associate Professor, Decart University, Paris, France
	2003-2005	Postdoctoral advisor, Dr. Raymond Brinas, Present position: Chemist Reviewer, FDA, Washington, DC.
	2003-2008	Postdoctoral advisor, Dr. Olga Finikova, Present position: Intellectual Property Specialist, Global Prior Art.
	2003-2008	Postdoctoral advisor, Dr. Sofia Apreleva, Present position: Research Scientist, Merck Inc.
	2004-2005	Postdoctoral advisor, Dr. Michael Yurchenko, Present position: Development Scientist, Hexcel Corporation.
	2006-2008	Postdoctoral advisor, Dr. Artem Lebedev, Present position: Director for Research, Trace-Ability Inc.
	2007	Three lectures on Biomimetics in Chem700
	2008-Present	Small group discussion leader, Intermediary Biochemistry course to first year medical students PennMedicine
	2008-Present	BMB 508, Macromolecular Biophysics: Principles and Methods, 3 lectures on Optical Spectroscopy and Imaging
x	2008-2014	Chair of the dissertation committee, Lee Solomon (BMB student)
	2008-2011	Postdoctoral advisor, Dr. Emmanouil Roussakis, Present position: Senior Research Associate, Wellman Center for Photomedicine, MGH/Harvard Medical School.
	2008-2011	Postdoctoral advisor, Dr. Louise Sinks, Present position: Senior Research Scientist, US Nano LLC.
	2009-2013	Member of the dissertation committee, Melissa Martinez (BMB student)

2009-2014	Chair of the dissertation committee, Molly Sheehan (BMB student)
2009-2013	PhD advisor, Tomoyasu Mani (BMB student), Present position: Associate Professor, University of Connecticut.
2009-2011	Postdoctoral advisor, Dr. Sujatha Thyagarajan, Present position: Research Associate, Martinos Center for Biomedical Imaging, MGH/Harvard Medical School.
2009-2019	Postdoctoral advisor, Dr. Tatiana Esipova, Present position: Assistant Professor, La Jolla University, Chicago, IL.
2010-Present	Member of the dissertation committee, Bryan Fry (BMB student)
2010-Present	Member of the dissertation committee, Nathan Ennist (BMB student)
2010-2014	Member of the dissertation committee, Kate Smith-DuPont (BMB student)
2010-2014	Member of the dissertation committee, Rob Culick (BMB student)
2012-Present	Member of the dissertation committee, Deborah Schroder (BMB student)
2012-Present	Member of the dissertation committee, Beatrice Markiewicz (Chemistry student)
2013-Present	Member of the dissertation committee, Chris Bialas (BMB student)
2013-Present	Chair of the dissertation committee, Josh Mancini (BMB student)
2013-Present	Member of the dissertation committee, Elizabeth Dempsey-Higbee (BMB student)
2013-Present	Chair of the dissertation committee, Ismail Ahmed (BMB student)
2013-Present	Member of the dissertation committee, Catherine DeBrosse (BMB student)
2013-Present	Member of the dissertation committee, Rachel Abaskharon-Roesch (Chemistry student)
2014	Guest lecturer (five lectures on Applications of Photochemistry and Photophysics in Biological Imaging), Department of Chemistry, University of Bologna, Italy
2014-2019	Member of the dissertation committee, Theresa Rapp (Chemistry student)
2015-2021	PhD advisor, Martin Iwanicki (BMB student)
2015-2018	Postdoctoral advisor, Dr. Shane Plunkett
2015-2019	Postdoctoral advisor, Dr. Mirna El-Khatib
2015-2018	Postdoctoral advisor, Dr. Luca Ravotto
2017-2018	Postdoctoral advisor, Dr. Dmitry Andrianov
2017-2019	Postdoctoral advisor, Dr. Srinivasa Rao Allu
2020-2022	Postdoctoral advisor, Dr. Sapna Ahuja
2022-present	Postdoctoral advisor, Dr. Simin Belali
2022-present	Postdoctoral advisor, Dr. Komal Rizwan

Bibliography:

Research Publications, peer reviewed (2018-2022):

2022

Chong, S. H,; Ong, Y. H.; El Khatib, M.; Allu, S. R.; Parthasarathy, A. B.; Greenberg, J. H.; Yodh, A.

G.*; Vinogradov, S. A.* Real-time tracking of brain oxygen gradients and blood flow during functional activation. *Neurophotonics*, **2022**, 9(4), 045006. doi.org/10.1117/1.NPh.9.4.045006

El Khatib, M.; Cheprakov, A. V.; Vinogradov, S. A. Unusual reactivity and metal affinity of water-soluble dipyrrins. *Inorg. Chem.*, **2022**, 61(32), 12746-12758. doi.org/10.1021/acs.inorgchem.2c01834

Van Slyke, A. L.; El Khatib, M.; Velalopoulou, A.; Diffenderfer, E. E.; Shoniyozov, K.; Kim, M. M.; Karagounis, I. V.; Busch, T. M.; Vinogradov, S. A.; Koch, C. J.; Wiersma, R. D. Oxygen monitoring in model solutions and *in vivo* in mice during proton irradiation at conventional and FLASH dose rates. *Radiat. Res.*, **2022**, 198(2), 181-189. doi: 10.1667/RADE-21-00232.1

El Khatib, M.; Van Slyke, A. L.; Velalopoulou, A.; Kim, M. M.; Shoniyozov, K.; Rao Allu, S.; Diffenderfer, E. E.; Busch, T. M.; Wiersma, R. D.; Koch, C. J.; Vinogradov, S. A. Ultrafast tracking of oxygen dynamics during proton FLASH. *Int. J. Radiat. Oncol. Biol. Phys.*, **2022**, 113(3), 624-634. doi: 10.1016/j.ijrobp.2022.03.016

Erlebach, E.; Ravotto, L.; Wyss, M. T.; Condrau, J.; Troxler, T.; Vinogradov, S. A.*; Weber, B.* Measurement of cerebral oxygen pressure in living mice by two-photon phosphorescence lifetime microscopy. *STAR Protocols*, **2022**, 3(2): 101370. doi: 10.1016/j.xpro.2022.101370

Abdelfattah, A. S. et al. (over 50 authors) Neurophotonic tools for microscopic measurements and manipulation: status report *Neurophotonics*, **2022**, Article Number: 013001. doi: 10.1117/1.NPh.9.S1.013001

2021

Zhai, Y.; Schilling, K.; Wang, T.; El Khatib, M.; Vinogradov, S. A.; Brown, E. B.; Zhang, X. Spatiotemporal blood vessel specification at the osteogenesis and angiogenesis interface of biomimetic nanofiber-enabled bone tissue engineering. *Biomaterials*, **2021**, 276, Article number: 121041.

Cao, X.; Zhang, R.; Esipova, T.; Allu, S. R.; Ashraf, R.; Rahman, M; Gunn, J. R.; Bruza, P.; Gladstone, D. J.; Williams, B. B.; Swartz, H. M.; Hoopes, P. J.; Vinogradov, S. A.*; Pogue, B. W.* Quantification of oxygen depletion during FLASH irradiation *in vitro* and *in vivo*. *International Journal of Radiation Oncology, Biology, Physics*, **2021**, 111(1), 240−248.

Allu, S. R.; Ravotto, L.; Troxler, T.; Vinogradov, S. A. *syn*-Diarylphthalimidoporphyrins: Effects of symmetry breaking on two-photon absorption and linear photophysical properties. *J. Phys. Chem. A*, **2021**, 125(14), 2977-2988.

Hare, G. M. T.; Zhang, V.; Chin, K.; Thai, K.; Jacobs, E.; Cazorla-Bak, M. P.; Nghiem, L.; Wilson, D. F.; Vinogradov, S. A.; Connelly, K. A.; Mazer, D.; Evans, R. G.; Gilber, R. E. Impact of sodium glucose linked cotransporter-2 inhibition on renal microvascular oxygen tension in a rodent model of diabetes mellitus. *Physiological Reports*, **2021**, 2021;9:e14890.

Cao, X.; Allu, S. R.; Jiang, S. D.; Gunn, J. R.; Yao, C. P.; Xin, J.; Bruza, P.; Gladstone, D. J.; Jarvis, L. A.; Tian, J.; Swartz, H. M.; Vinogradov, S. A.; Pogue, B. W. High-resolution pO_2 imaging improves quantification of the hypoxic fraction in tumors during radiation therapy. *International Journal of Radiation Oncology, Biology, Physics*, **2021**, 109, 603-613.

Pogue, B. W.; Zhang, R.; Cao, X.; Jia, J. M.; Petusseau, A.; Bruza, P.; Vinogradov, S. A. Review of *in vivo* optical molecular imaging and sensing from x-ray excitation. *J. Biomed. Optics*, **2021**, 26(1), Article number: 010902.

2020

Ravotto, L.; Meloni, S. L.; Esipova, T. V.; Masunov, A. E.; Anna, J. M.; Vinogradov, S. A. Three-photon spectroscopy of porphyrins *J. Phys. Chem. A*, **2020**, 124(52) 11038–11050.

Chin, K.; Cazorla-Bak, M. P.; Liu, E. E.; Nghiem, L.; Zhang, Y. L.; Yu, J. L.; Wilson, D. F.; Vinogradov, S. A.; Gilbert, R. E.; Connelly, K. A.; Evans, R. G.; Baker, A. J.; Mazer, C. D.; Hare, G. M. T. Renal microvascular oxygen tension during hyperoxia and acute hemodilution assessed by phosphorescence quenching and excitation with blue and red light. *Can. J. Anesthesia D*, **2020**, 12.

Cao, X., Gunn, J. R., Allu, S. R., Bruza, P., Jiang, S., Vinogradov, S. A. Pogue, B. W. Implantable sensor for local Cherenkov-excited luminescence imaging of tumor pO_2 during radiotherapy. *J. Biomed. Optics*, **2020**, 25(11), Article number: 112704.

Ballester, M.; Ravotto, L.; Quirke, J. M. E.; de la Vega, R. L.; Shelnutt, J. A.; Cheprakov, A. V.; Vinogradov, S. A.;* Medforth, C. J.* Protonation of planar and nonplanar porphyrins: a calorimetric and computational study. *J. Phys. Chem. A*, **2020**, 124(43), 8994-9003.

Sencan, I.; Esipova, T.; Kilic, K.; Li, B. Q.; Desjardins, M.; Yaseen, M. A.; Wang, H.; Porter, J. E.; Kura, S.; Fu, B. Y.; Secomb, T. W.; Boas, D. A.; Vinogradov, S. A.; Devor, A.; Sakadzic, S. Optical measurement of microvascular oxygenation and blood flow responses in awake mouse cortex during functional activation. *J. Cereb. Blood Flow & Metab.* **2020**, Article number: 0271678X20928011.

Abrahamson, J. R.; Read, A.; Chin, K.; Mistry, N.; Joo, H.; Desjardins, J. F.; Liu, E.; Thai, K.; Wilson, D. F.; Vinogradov, S. A.; Maynes, J. T.; Gilbert, R. E.; Connelly, K. A.; Baker, A. J.; Mazer, C. D.; Hare, G. M. T. Renal tissue pO_2 sensing during acute hemodilution is dependent on the diluent. *Am. J. Physiol.*, **2020**, 318(4), R799-R812.

Ong, Y. H.; Miller, J.; Yuan, M.; Chandra, M.; El Khatib, M.; Vinogradov, S. A.; Putt, M. E.; Zhu, T. C.; Cengel, K. A.; Yodh, A. G.; Busch, T. M. Blood flow measurements enable optimization of light delivery for personalized photodynamic therapy. *Cancers*, **2020**, 12(6).

Bartosik, P.; Fitzgerald, J.; El Khatib, M.; Yaseen, M. A.; Vinogradov, S. A., Niedre, M. Prospects for the Use of Upconverting Nanoparticles as a Contrast Agent for Enumeration of Circulating Cells *in vivo* *Intl. J. Nanomed.*, **2020**, 15, 1709-1719.

Christodoulou, C.; Spencer J. A.; Turcotte, R.; Kokkaliaris, K.D.; Panero, R.; Ramos, A.; Esipova, T. V.; Vinogradov, S. A.; Rudzinskas, S.; Zhang, Y.; Perkins, A.S.; Schroeder, T.; Lin, C. P.; Camargo, F. Live-Animal Imaging of Native Hematopoietic Stem and Progenitor cells, *Nature* **2020**, 578, 278-283.

Cao, X.; Rao Allu, S.; Jiang, S.; Jia, M.; Gunn, J. R.; Yao, C.; LaRochelle, E. P.; Shell, J. R.; Bruza, P.; Gladstone, D. J.; Jarvis, L. A.; Tian, J.; Vinogradov, S. A.;* Pogue, B. W.* Tissue pO_2 Distributions in Xenograft Tumors Dynamically Imaged by Cherenkov-Excited Phosphorescence during Fractionated Radiation Therapy, *Nature Commun.* **2020**, 11, Article number: 573.

Isokuortti, J.; Rao Allu, S.; Efimov, A.; Vuorimaa-Laukkanen, E.; Tkachenko, N. V.; Vinogradov, S. A.; Laaksonen, T.; Durandin, N. A. Endothermic and Exothermic Energy Transfer Made Equally Efficient for Triplet−Triplet Annihilation Upconversion, *J. Phys. Chem. Lett.* **2020**, 11, 318-324.

Plunkett, S.; El Khatib, M.; Sencan, I.; Porter, J.; Kumar, A. T. N.; Collins, J.; Sakadzic, S.; Vinogradov, S. A. *In vivo* deep-tissue microscopy with UCNP/Janus-dendrimers as imaging probes: resolution at depth and feasibility of ratiometric sensing, *Nanoscale* **2020**, 12, 2657-2672, DOI:

10.1039/c9nr07778b.

2019

Sencan, I.; Esipova, T. V.; Yaseen, M. A.; Fu, B.; Boas, D. A.; Vinogradov, S. A.;* Shahidi, M.;* Sakadzic, S.* Two-photon phosphorescence lifetime microscopy of retinal capillary plexus oxygenation in mice. *J. Biomed. Opt.* **2019,** *23* (12), 26501.

Villa, M.; Del Secco, B.; Ravotto, L.; Roy, M.; Rampazzo, E.; Zaccheroni, N.; Prodi, L.; Gingras, M.;* Vinogradov, S. A.;* Ceroni, P.* Bright Phosphorescence of All-Organic Chromophores Confined within Water-Soluble Silica Nanoparticles. *J. Phys. Chem. C* **2019,** *123* (49), 29884-29890.

Schilling, K.; El Khatib, M.; Plunkett, S.; Xue, J. J.; Xia, Y. N.; Vinogradov, S. A.;* Brown, E.;* Zhang, X. P.* Electrospun Fiber Mesh for High-Resolution Measurements of Oxygen Tension in Cranial Bone Defect Repair. *ACS Appl. Mater. & Interf.* **2019,** *11* (37), 33548-33558.

Rytelewski, M.; Haryutyunan, K.; Nwajei, F.; Shanmugasundaram, M.; Wspanialy, P.; Zal, M. A.; Chen, C. H.; El Khatib, M.; Plunkett, S.; Vinogradov, S. A.; Konopleva, M.; Zal, T. Merger of dynamic two-photon and phosphorescence lifetime microscopy reveals dependence of lymphocyte motility on oxygen in solid and hematological tumors. *J. Immunotherapy of Cancer* **2019,** *7*.

Li, B. Q.; Esipova, T. V.; Sencan, I.; Kilic, K.; Fu, B. Y.; Desjardins, M.; Moeini, M.; Kura, S.; Yaseen, M. A.; Lesage, F.; Ostergaard, L.; Devor, A.; Boas, D. A.; Vinogradov, S. A.; Sakadzic, S. More homogeneous capillary flow and oxygenation in deeper cortical layers correlate with increased oxygen extraction. *eLife* **2019,** *8*.

Esipova, T. V.; Barrett, M. J. P.; Erlebach, E.; Masunov, A. E.; Weber, B.; Vinogradov, S. A. Oxyphor 2P: A High-Performance Probe for Deep-Tissue Longitudinal Oxygen Imaging. *Cell Metabolism* **2019,** *29* (3), 736.

Canola, S.; Mardegan, L.; Bergamini, G.; Villa, M.; Acocella, A.; Zangoli, M.; Ravotto, L.; Vinogradov, S. A.;* Di Maria, F.; Ceroni, P.;* Negri, F.* One- and two-photon absorption properties of quadrupolar thiophene-based dyes with acceptors of varying strengths. *Photochem. Photobiol. Sci.* **2019,** *18* (9), 2180-2190.

Del Secco, B.; Ravotto, L.; Esipova, T. V.; Vinogradov, S. A.;* Genovese, D.; Zaccheroni, N.; Rampazzo, E.;* Prodi, L.* Optimized synthesis of luminescent silica nanoparticles by a direct micelle-assisted method. *Photochem. Photobiol. Sci.* **2019,** *18* (9), 2142-2149.

2018

Ahmed, S. R.; Jia, J. M.; Bruza, P.; Vinogradov, S.; Jiang, S. D.; Gladstone, D. J.; Jarvis, L. A.; Pogue, B. W. Radiotherapy-induced Cherenkov luminescence imaging in a human body phantom. *J. Biomed. Opt.* **2018,** *23* (3).

Friedman, E. S.; Bittinger, K.; Esipova, T. V.; Hou, L.; Chau, L.; Jiang, J.; Mesaros, C.; Lund, P. J.; Liang, X.; FitzGerald, G. A.; Goulian, M.; Lee, D.; Garcia, B. A.; Blair, I. A.; Vinogradov, S. A.;* Wu, G. D.* Microbes *vs* chemistry in the origin of the anaerobic gut lumen. *PNAS* **2018,** *115* (16), 4170-4175.

Kisler, K.; Lazic, D.; Sweeney, M. D.; Plunkett, S.; El Khatib, M.; Vinogradov, S. A.; Boas, D. A.; Sakadzic, S.; Zlokovic, B. V. *In vivo* imaging and analysis of cerebrovascular hemodynamic responses

and tissue oxygenation in the mouse brain. *Nature Protocols* **2018,** *13* (6), 1377-1402.

Pogue, B. W.; Feng, J.; LaRochelle, E. P.; Bruza, P.; Lin, H.; Zhang, R.; Shell, J. R.; Dehghani, H.; Davis, S. C.; Vinogradov, S. A.; Gladstone, D. J.; Jarvis, L. A. Maps of *in vivo* oxygen pressure with submillimetre resolution and nanomolar sensitivity enabled by Cherenkov-excited luminescence scanned imaging. *Nature Biomed. Eng.* **2018,** *2* (4), 254-264.

Sencan, I.; Esipova, T. V.; Yaseen, M. A.; Fu, B. Y.; Boas, D. A.; Vinogradov, S. A.; Shahidi, M.; Sakadzic, S. Two-photon phosphorescence lifetime microscopy of retinal capillary plexus oxygenation in mice. *J. Biomed. Opt.* **2018,** *23* (12).

Suilender, C. T.; Mark, A. E.; Clark, T. A.; Esipova, T. V.; Vinogradov, S. A.; Jones, T. A.; Dunn, A. K. Imaging of cortical oxygen tension and blood flow following targeted photothrombotic stroke. *Neurophotonics* **2018,** *5* (3).

Editorials, Reviews, Chapters, including participation in committee reports (print or other media):

1. D.F.Wilson, S.A.Vinogradov, A.Mokashi, A.Pastuszko, S.Lahiri and M.W.Dewhirst: Tissue oxygen pressure and oxygen sensing by the carotid body. Oxygen Homeostasis and Its Dynamics,Springer-Verlag, Tokyo Y. Ishimura, H.Shimada, M.Suematsu (eds.). Page: 377-387, 1998.

2. Vinogradov, S.A., Wilson, D.F. : Porphyrin-dendrimers as biological oxygen sensors. Designing dendrimers. Wiley, 2012.

Patents:

self-owned: Phosphorescent dendritic macromolecular compounds for imaging tissue oxygen. USA Patent Number 5,837,865, 1998.

self-owned: Method for rapid detection of bacterial growth in cultures. USA Patent Number 6,165,741, 2000.

self-owned: Apparatus and for non-invasive imaging oxygen distribution in multi-dimensions. USA Patent Number 6,274,086 B1, 2001.

self-owned: Method and apparatus for determining the effect of a drug on cells. USA Patent Number 6,395,555 B1, 2002.

self-owned: Porphyrin compounds for imaging tissue oxygen. USA Patent Number 6,362,175 B1, 2002.

self-owned: Apparatus for measuring oxygen concentration gradient and method of use thereof. USA Patent Number 6,701,168 B1, 2004.

self-owned: Imaging of oxygen by phosphorescence quenching. USA Patent Number 8,135,449 B2, 2012.

Self-owned: Improved phosphorescent molecules for measuring oxygen and imaging methods. USA Patent Number 61/603,668 - provisional, 2013.

Penn: Dendritic upconverting nanoprobes. USA Patent Number US-2014-0004048-A1, 2014.

Penn: Method of synthesis of 5,5'-disubstituted pi-extended dipyrromethenes and their use as analytical reagents for metal ions and fluorescent imaging probes. USA Patent Number 8,877,942, 2014.