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Joel N. Bixler

Education

Doctor of Philosophy in Biomedical Engineering *Dec. 2015*

Texas A&M University
Advisor: Dr. Vladislav V. Yakovlev
GPA: 4.00 / 4.00

Masters of Science in Biomedical Engineering *Dec. 2012*

Texas A&M University
Advisor: Dr. Kristen C. Maitland

Bachelor of Science in Biomedical Engineering *May 2010*

University of Texas at Austin

Work Experience

Senior Research Biomedical Engineer, DR-03 *Jan. 2016 - Present*

Air Force Research Laboratory / 711th Human Performance Wing,
Bioeffects Division, Optical Radiation Bioeffects Branch

Mentors: Dr. Robert J. Thomas and Dr. Benjamin A. Rockwell

- Principle investigator for AFOSR funded grant (3 year, $1M) developing ultrafast imaging systems for studying fundamental interactions of electromagnetic energy with biology, including laser tissue interaction and the mechanisms of electrical stimulation and poration. Research focuses include developing compressed ultrafast photography based microscopy (capable of imaging at up to 100 billion frames per second) for ultrafast imaging of cells and neurons, and the use of streak cameras for studying ultrafast dynamics in biology.
- Principle investigator and team lead for Bioeffects Division efforts to measure dynamic tissue optical properties. Efforts focus on developing novel methods for *in vivo* measurements of tissue optical properties at high speeds to enable a more advanced understanding of changes in the properties as a function of temperature and state, up to the point of ablation. Additional research is focused on applying machine learning to invert forward Monte Carlo methods to extract properties from experimental measurements.
- Program Manager for $2.0M per fiscal year in AFRL 6.2 (fundamental science) research funding. Manage a team of 10 principal investigators with executing research funding based on cost, schedule, and performance.
- Additional imaging interests include the use of lattice light sheet microscopy as a high-speed, 3D imaging method to study directed energy interactions in 3D cell and neuronal cultures.
- Over $2.5 million of research funding over 5 year period with AFRL. Funding agencies include the Air Force Office of Scientific Research, DARPA, the Defense Health Agency, and the 711 HPW Chief Scientist.
- Program Manager for for our country's $3 Billion SBIR/STTR product commercialization program. Current awards focus on the development of novel technologies for measuring the optical properties of biological tissue.

Pathways Biomedical Engineer *Feb. 2014 - Dec. 2015*

Air Force Research Laboratory / 711th Human Performance Wing,
Airman Systems Directorate, Bioeffects Division, Optical Radiation
Bioeffects Branch
Supervisors: Dr. Robert J. Thomas and Dr. Benjamin A. Rockwell

- Supervised and mentored summer interns, guiding the successful completion of multiple research projects.
- Developed a Monte Carlo model for accurately simulating focusing light beams.
- Designed and constructed a fiber probe system for measuring the optical properties of biological tissue.

Graduate Research Assistant *Aug. 2012 - May 2014*

Texas A&M University: Department of Biomedical Engineering

Supervisor: Dr. Vladislav V. Yakovlev

- Developed novel integrating cavity based spectroscopy techniques for use in enhancing linear optical phenomena such as fluorescence and Raman excitation. Demonstrated proof-of-principle experiments with results published in the *Proceedings of the National Academy of Science*.
- Experimentally demonstrated significant Raman enhancement ($> 10^5$) based on integrating cavity enhanced spectroscopy, with applications including environmental sensing and breath analysis.
- Designed and constructed a flow-through integrating cavity that can be used for analysis of gases via spontaneous Raman spectroscopy.

TASC Inc., Graduate Student Engineering Intern *June 2013 - Feb. 2014*

TASC Inc., San Antonio, TX

Supervisors: Dr. Benjamin A. Rockwell and Dr. Robert J. Thomas

- Developed a method independent of scattering for measuring the absorption coefficient of biological cells.
- Demonstrated remote spectroscopic sensing at distances up to 400 m
- Contributed to experimental design and data collection for experiments demonstrating for the first time random Raman lasing in bulk material.

Repperger Summer Research Fellow *May 2012 - Aug. 2012*

Air Force Research Lab, 711th HPW Bioeffects Division

Supervisor: Dr. Jeff Oliver

- Designed and constructed a speckle imaging system to measure blood flow in the retina.
- Contributed to the experimental design plan for the Biomarker and Sensitive Evaluation of Laser Lesions research project.

Graduate Research Assistant *Aug. 2010 - May 2012*

Texas A&M University: Department of Biomedical Engineering

Supervisor: Dr. Kristen C. Maitland

- Designed fiber optic based fluorescence imaging system using a optical fiber bundle for use in *in vivo* imaging of respiratory bacterial infections.
- Incorporated fiber based excitation into a IVIS whole-animal imaging system, greatly enhancing the detection sensitivity for fluorescence based imaging of respiratory infections in animal models. Patent application filed based on this technology.

Undergraduate Research Assistant *Sept. 2008 - May 2010*

University of Texas at Austin: Department of Biomedical Engineering

Supervisor: Prof. Andy Dunn

- Assisted with the construction of a multimodal microscope system for simultaneous imaging of oxygen tension and blood flow during focal ischemia.
- Analyzed speckle contrast image data to generate blood flow maps prior to and during the onset of focal ischemia.

Sandia Laboratories Student Intern *May 2005 - Aug. 2007*

Sandia National Laboratory

Supervisor: Dr. May Nyman

- Worked in an inorganic chemistry laboratory under the supervision of Dr. May Nyman and Dr. Travis Anderson. Job duties included synthesis of niobium and tantalum-based oxide complexes and analysis of synthesized compounds.
- Analyzed molecular structure using X-ray diffraction, scanning electron microscope imaging, NMR and IR spectroscopy, and thermogravimetric and differential thermal analysis.

Teaching Experience *Sept. 2010 - May 2012*

Texas A&M University

Supervisors: Dr. Kristen Maitland and Dr. Kenith Meissner

- Teaching Assistant for BMEN 305: Bioinstrumentation. This course focused on basic circuit design and signal acquisition using the NI ELVIS II system in conjunction with LabVIEW. Lab assignments included building a circuit capable of collecting ECG signals, building a basic pulse oximeter, and teaching students basic signal acquisition and analysis methodology available in LabVIEW.
- Teaching Assistant for BMEN 306: Bioinstrumentation Lab. Taught two labs based on absorption and fluorescence spectroscopy.
- Teaching Assistant for BMEN 440/640: Medical Device Design.

Technical Skills

- Optical systems (ultrafast laser oscillators and amplifiers, streak camera photography, imaging systems, microscopy)
- Spectroscopy (Raman, fluorescence, Brillouin, non-linear spectroscopy)
- MATLAB / Python / Octave
- Monte Carlo simulations
- SOLIDWORKS
- Recognized expert in laser tissue interaction
- Experience with human use and animal use protocols.

Professional Societies

Conference Chair: Optical Interactions with Tissue and Cells, SPIE Photonics West *2022 - current*

Conference Committee: IEEE Rapid *2022 - current*

Conference Committee: Optical Interactions with Tissue and Cells, SPIE Photonics West *2018 - current*

SPIE Member *2016 - current*

Directed Energy Professional Society Member *2019 - current*

Texas A&M SPIE Student Chapter President *2012 - 2014*

Texas A&M SPIE Student Chapter Optics Outreach *2012 - 2015*

Awards and Honors

AFRL Early Career Award *2022*

Gen Lester L. Lyles Award, Air Force Material Command *2021*

711 Human Performance Wing, Category III Civilian of the Quarter *4th Quarter 2019*

Bioeffects Division, Category III Civilian of the Year *2017*

711th Human Performance Wing Civilian of the Quarter *3rd Quarter 2017*

AFRL Pathways Fellowship *2014-2016*

Newport Research Excellence Award *2014*

SPIE Officer Travel Grant *2014*

Office of Graduate Studies Travel Award *2013*

TAMU OGAPS Research and Presentation Grant *2013*

Repperger Fellowship *2012*

Lechner Graduate Fellowship *2010*

Invited Talks

[6] Nanosecond imaging of cell membrane voltage using strobe photography and streak camera microscopy, *Electroporation Based Technologies and Treatments*, Ljubljana, Slovenia, 2022.

[5] Ultrafast Imaging of EM Interaction with Cells, *Physics of Quantum Elecrtronics*, Snowbird UT, 2019.

[4] Towards the direct observation of cell membrane dynamics in response to stimuli through the use of streak camera imaging, *INRS*, Montreal Canada, 2018.

[3] Spatial coherence of random Raman lasing emission, *CLEO: QELS Fundamental Science*, San Jose CA, 2015.

[2] Integrating cavity measurements: a new paradigm in spectroscopic optical characterization, *Physics of Quantum Electronics*, Snowbird UT, 2015.

[1] Random lasing via a Raman transition, *Physics of Quantum Electronics*, Snowbird UT, 2015.

Contributed Talks / Conference Papers

[26] Optical properties of porcine skin and subcutaneous tissue following various methods of cold storage. (https://doi.org/10.1117/12.2611109) *SPIE BiOS*, San Francisco, CA, 2022.

[25] Segmenting quantitative phase images of neurons using a deep learning model trained on images generated from a neuronal growth model. (https://doi.org/10.1117/12.2608770) *SPIE BiOS*, San Francisco, CA, 2022.

[24] Simultaneous quantitative phase imaging and Brillouin spectroscopy determine cell longitudinal modulus. (https://doi.org/10.1117/12.2608890) *SPIE BiOS*, San Francisco, CA, 2022.

[23] Quantitative phase microscopy monitors cellular water content and other biophysical parameters during electroporation. (https://doi.org/10.1117/12.2606897) *SPIE BiOS*, San Francisco, CA, 2022.

[22] Dynamic nitrogen vacancy magnetometry via compressed single-shot imaging. (https://doi.org/10.1117/12.2612170) *SPIE BiOS*, San Francisco, CA, 2022.

[21] Compressed hyperspectral Raman microscope for imaging tissues and cellular structures. (https://doi.org/10.1117/12.2544571) *SPIE BiOS*, San Francisco, CA, 2020.

[20] Neural network generation for estimation of tissue optical properties. (https://doi.org/10.1117/12.2546068) *SPIE BiOS*, San Francisco, CA, 2020.

[19] Applications for compressed ultrafast photography to biological imaging and sensing. (https://doi.org/10.1117/12.2540049) *Biophotonics Australasia*, Melbourne, Australia, 2019.

[18] Evaluation of membrane potential changes induced by unipolar and bipolar nanosecond pulsed electric fields. (https://doi.org/10.1117/12.2511189) *SPIE BiOS Phononics West*, San Francisco CA, 2019.

[17] Informational bioeffects Atlas of laser lesions (IBALL) – Developing an online database for clinicians and researchers. (https://doi.org/10.2351/1.5118530) *ILSC 2019*, South Kissimmee, Fl, 2019.

[16] Comparison of various neural network-based models for retinal lesion analysis. (https://doi.org/10.1117/12.2507908) *SPIE BiOS Photonics West*, San Francisco CA, 2019.

[15] High speed fluorescence imaging with compressed ultrafast photography. (https://doi.org/10.1117/12.2251025) *SPIE BiOS Photonics West*, San Francisco CA, 2017.

[14] Single-shot chemical detection and identification with compressed hyperspectral Raman imaging. (10062-13) *SPIE BiOS Photonics West*, San Francisco CA, 2017.

[13] Methods for variance reduction in Monte Carlo simulations. (https://doi.org/10.1117/12.2213470) *SPIE BiOS Photonics West*, San Francisco CA, 2016.

[12] Evidence of Anderson localization effects in random Raman lasing. (https://doi.org/10.1117/12.2212911) *SPIE LASE Photonics West*, San Francisco CA, 2016.

[11] Accurately modeling Gaussian beam propagation in the context of Monte Carlo techniques. (https://doi.org/10.1117/12.2213653) *SPIE BiOS Photonics West*, San Francisco CA, 2016.

[10] Lighting up microscopy with random Raman lasing. (9732-08) *SPIE LASE Photonics West*, San Francisco CA, 2016.

[9] Evidence of Anderson localization effects in random Raman lasing. (9731-10) *SPIE LASE Photonics West*, San Francisco CA, 2016.

[8] Low cost integrating cavity for monitoring of environmental toxins. (9314-0T) *SPIE BiOS Photonics West*, San Francisco CA, 2015.

[7] Flow-through integrating cavity for analysis of exhaled breath. (8570) *SPIE BiOS Photonics West*, San Francisco CA, 2015.

[6] Modeling tissue heating under tunable near IR radiation. (9321-0D) *SPIE BiOS Photonics West*, San Francisco CA, 2015.

[5] A new SERS: scattering enhanced Raman spectroscopy. (8939-09) *SPIE BiOS Photonics West*, San Francisco CA, 2014.

[4] Remote spectroscopy at kilometer-scale distances via random Raman lasing. (SM4E:3) *CLEO: Science and Innovations*, San Jose CA, 2014.

[3] Ultrasensitive absorption and ultrasensitive and simple Raman measurements for biomedical optical spectroscopy and sensing. (Spectroscopy in Biology and Medicine) *Physics of Quantum Electronics*, Snowbird UT, 2014.

[2] Measurement of the absorption coefficient of biological materials using integrating cavity ring-down spectroscopy. (BS4B.5) *OSA Biomedical Optics*, Miami FL, 2014.

[1] Multi-scale fluorescence imaging of bacterial infections in animal models. (8565-37) *SPIE BiOS*, San Francisco CA, 2013.

Patents

[4] Electronic Speckle Pattern Interferometer (ESPI) for long-range measurement of displacement of materials within hazardous environments. United States Patent Application 17/335,804.

[3] High reflectivity integrating cavity and optical amplification device. US Patent No: 9,927,417.

[2] Scanning microscope using a probe beam deflection technique. US Patent No: 10,557,793.

[1] Ultrafast strobe imaging using a rotary mirror. Patent Application under AFRL review.

Peer Reviewed Publications

[33] E. M. Gil, Z. A. Steelman, A. Sedelnikova, and J. N. Bixler. "Comparing the segmentation of quantitative phase images of neurons using convolutional neural networks trained on simulated and augmented imagery". *Neurophotonics* **10**, 35004 (2023). DOI: 10.1117/1.NPh.10.3.035004.

[32] V. Kim, I. Semenov, A. S. Kiester, M. A. Keppler, B. L. Ibey, J. N. Bixler, R. M. L. Colunga Biancatelli, and A. G. Pakhomov. *Control of the Electroporation Efficiency of Nanosecond Pulses by Swinging the Electric Field Vector Direction*. 2023. DOI: 10.3390/ijms241310921.

[31] E. Gudvangen, U. Mangalanathan, I. Semenov, A. S. Kiester, M. A. Keppler, B. L. Ibey, J. N. Bixler, and A. G. Pakhomov. *Pulsed Electric Field Ablation of Esophageal Malignancies and Mitigating Damage to Smooth Muscle: An In Vitro Study*. 2023. DOI: 10.3390/ijms24032854.

[30] Z. A. Steelman, S. Martens, J. Tran, Z. N. Coker, A. Sedelnikova, A. S. Kiester, S. P. O'Connor, B. L. Ibey, and J. N. Bixler. "Rapid and precise tracking of water influx and efflux across cell membranes induced by a pulsed electric field". *Biomedical Optics Express* **14**, 1894–1910 (2023). DOI: 10.1364/BOE.485627.

[29] V. Kim, I. Semenov, A. S. Kiester, M. A. Keppler, B. L. Ibey, J. N. Bixler, and A. G. Pakhomov. "Action spectra and mechanisms of (in) efficiency of bipolar electric pulses at electroporation". *Bioelectrochemistry* **149**, 108319 (2023). DOI: https://doi.org/10.1016/j.bioelechem.2022.108319.

[28] M. A. Keppler, M. A. Keppler, Z. A. Steelman, Z. N. Coker, M. Nesládek, M. Nesládek, M. Nesládek, P. R. Hemmer, V. V. Yakovlev, V. V. Yakovlev, and J. N. Bixler. "Dynamic nitrogen vacancy magnetometry by single-shot optical streaking microscopy". *Photonics Research, Vol. 10, Issue 9, pp. 2147-2156* **10**, 2147–2156 (2022). DOI: 10.1364/PRJ.455634.

[27] Z. A. Steelman, Z. N. Coker, A. Sedelnikova, M. A. Keppler, A. S. Kiester, M. A. Troyanova-Wood, B. L. Ibey, and J. N. Bixler. "Comprehensive single-shot biophysical cytometry using simultaneous quantitative phase imaging and Brillouin spectroscopy". *Scientific Reports* **12**, 18285 (2022). DOI: 10.1038/s41598-022-23049-4.

[26] Z. N. Coker, M. Troyanova-Wood, Z. A. Steelman, B. L. Ibey, J. N. Bixler, and V. V. Yakovlev. "Brillouin microscopy monitors rapid stress responses in subcellular compartments". *Advanced Science (Under review)* (2022).

[25] E. M. Gil, M. Keppler, A. Boretsky, Vladislav, V Yakovlev, J. N. Bixler, and V. V. Yakovlev. "Segmentation of laser induced retinal lesions using deep learning (December 2021)". *Lasers in Surgery and Medicine* (2022). DOI: 10.1002/LSM.23578.

[24] J. N. Bixler, Z. A. Steelman, M. A. Keppler, A. Kiester, Z. N. Coker, and B. L. Ibey. "Ultrafast Imaging Technologies Enabling the Direct Observation of Directed Energy Interactions". *Journal of DoD Research and Engineering* **4** (2021).

[23] A. S. Kiester, B. L. Ibey, Z. N. Coker, A. G. Pakhomov, and J. N. Bixler. "Strobe photography mapping of cell membrane potential with nanosecond resolution". *Bioelectrochemistry*, 107929 (2021). DOI: 10.1016/J.BIOELECHEM.2021.107929.

[22] Z. A. Steelman, Z. N. Coker, A. Kiester, G. Noojin, B. L. Ibey, and J. N. Bixler. "Quantitative phase microscopy monitors subcellular dynamics in single cells exposed to nanosecond pulsed electric fields". *Journal of Biophotonics*, e202100125 (2021). DOI: 10.1002/jbio.202100125.

[21] Z. A. Steelman, A. Sedelnikova, Z. N. Coker, A. Kiester, G. Noojin, B. L. Ibey, and J. N. Bixler. "Visualizing bleb mass dynamics in single cells using quantitative phase microscopy". *Applied Optics* **60**, G10 (2021). DOI: 10.1364/ao.426147.

[20] B. H. Hokr and J. N. Bixler. "Machine learning estimation of tissue optical properties". *Scientific Reports* **11**, 6561 (2021). DOI: 10.1038/s41598-021-85994-w.

[19] Z. N. Coker, X. Liang, A. S. Kiester, G. D. Noojin, J. N. Bixler, B. L. Ibey, A. Vogel, and V. V. Yakovlev. "Synergistic effect of short optical and electrical pulses on dielectric breakdown". *Photonics Research* **9**, 416–423 (2021). DOI: 10.1364/prj.411980.

[18] P. D. Cook, J. N. Bixler, R. J. Thomas, and E. A. Early. "Prediction of tissue optical properties using the Monte Carlo modeling of photon transport in turbid media and integrating spheres". *OSA Continuum* **3**, 1456 (2020). DOI: 10.1364/osac.377805.

[17] H. T. Beier, C. C. Roth, J. N. Bixler, A. V. Sedelnikova, and B. L. Ibey. "Visualization of Dynamic Sub-microsecond Changes in Membrane Potential". *Biophysical Journal* **116**, 120–126 (2019). DOI: 10.1016/j.bpj.2018.11.3129.

[16] J. V. Thompson, J. N. Bixler, B. H. Hokr, G. D. Noojin, M. O. Scully, and V. V. Yakovlev. "Single-shot chemical detection and identification with compressed hyperspectral Raman imaging". *Optics Letters* **42**, 2169 (2017). DOI: 10.1364/OL.42.002169.

[15] B. H. Hokr, J. V. Thompson, J. N. Bixler, D. T. Nodurft, G. D. Noojin, B. Redding, R. J. Thomas, H. Cao, B. A. Rockwell, M. O. Scully, and V. V. Yakovlev. "Enabling time resolved microscopy with random Raman lasing". *Scientific Reports* **7**, 1–7 (2017). DOI: 10.1038/srep44572.

[14] R. A. Barnes, C. C. Roth, H. T. Beier, G. D. Noojin, C. Valdez, J. N. Bixler, E. Moen, M. Shadaram, and B. L. Ibey. "Probe beam deflection optical imaging of thermal and mechanical phenomena resulting from nanosecond electric pulse (nsEP) exposure in-vitro". *Optics Express* **25**, 6621 (2017). DOI: 10.1364/OE.25.006621.

[13] F. Nooshabadi, H.-J. J. Yang, J. N. Bixler, Y. Kong, J. D. Cirillo, and K. C. Maitland. "Intravital Fluorescence Excitation in Whole-Animal Optical Imaging". *PLoS ONE* **11**, e0149932 (2016). DOI: 10.1371/journal.pone.0149932.

[12] J. N. Bixler, C. A. Winkler, B. H. Hokr, J. D. Mason, and V. V. Yakovlev. "Utilizing scattering to further enhance integrating cavity-enhanced spectroscopy". *Journal of Modern Optics* **63**, 1–4 (2015). DOI: 10.1080/09500340.2015.1066458.

[11] B. H. Hokr, J. N. Bixler, G. Elpers, B. Zollars, R. J. Thomas, V. V. Yakovlev, and M. O. Scully. "Modeling focusing Gaussian beams in a turbid medium with Monte Carlo simulations". *Optics Express* **23**, 8699 (2015). DOI: 10.1364/OE.23.008699.

[10] M. T. Cone, J. D. Mason, E. Figueroa, B. H. Hokr, J. N. Bixler, C. C. Castellanos, G. D. Noojin, J. C. Wigle, B. A. Rockwell, V. V. Yakovlev, E. S. Fry, G. D. Noojin, B. A. Rockwell, and V. V. Yakovlev. "Measuring the absorption coefficient of biological materials using integrating cavity ring-down spectroscopy". *Optica* **2**, 162–168 (2015). DOI: 10.1364/OPTICA.2.000162.

[9] J. N. Bixler, M. T. Cone, B. H. Hokr, J. D. Mason, E. Figueroa, E. S. Fry, V. V. Yakovlev, and M. O. Scully. "Ultrasensitive detection of waste products in water using fluorescence emission cavity-enhanced spectroscopy." *Proceedings of the National Academy of Sciences of the United States of America* **111**, 7208–11 (2014). DOI: 10.1073/pnas.1403175111.

[8] B. H. Hokr, J. N. Bixler, M. T. Cone, J. D. Mason, H. T. Beier, G. D. Noojin, G. I. Petrov, L. A. Golovan, R. J. Thomas, B. A. Rockwell, and V. V. Yakovlev. "Bright emission from a random Raman laser". *Nature Communications* **5**, 4356 (2014). DOI: 10.1038/ncomms5356.

[7] B. H. Hokr, J. N. Bixler, and V. V. Yakovlev. "Higher order processes in random Raman lasing". *Applied Physics A: Materials Science and Processing* **117**, 1–2 (2014). DOI: 10.1007/s00339-014-8722-7.

[6] B. H. Hokr, J. N. Bixler, G. D. Noojin, R. J. Thomas, B. A. Rockwell, V. V. Yakovlev, and M. O. Scully. "Single-shot stand-off chemical identification of powders using random Raman lasing." *Proceedings of the National Academy of Sciences of the United States of America* **111**, 12320–4 (2014). DOI: 10.1073/pnas.1412535111.

[5] J. N. Bixler, B. H. Hokr, M. L. Denton, G. D. Noojin, A. D. Shingledecker, H. T. Beier, R. J. Thomas, B. A. Rockwell, and V. V. Yakovlev. "Assessment of tissue heating under tunable near-infrared radiation". *Journal of Biomedical Optics* **19**, 070501 (2014). DOI: 10.1117/1.JBO.19.7.070501.

[4] J. M. Jabbour, M. A. Saldua, J. N. Bixler, and K. C. Maitland. "Confocal Endomicroscopy: Instrumentation and Medical Applications". *Annals of Biomedical Engineering* **40**, 378–397 (2012). DOI: 10.1007/s10439-011-0426-y.

[3] T. M. Anderson, T. M. Alam, M. A. Rodriguez, J. N. Bixler, W. Xu, J. B. Parise, and M. Nyman. "Cupric siliconiobate. Synthesis and solid-state studies of a pseudosandwich-type heteropolyanion". *Inorganic Chemistry* **47**, 7834–7839 (2008). DOI: 10.1021/ic800860q.

[2] T. M. Anderson, M. A. Rodriguez, T. A. Stewart, J. N. Bixler, W. Xu, J. B. Parise, and M. Nyman. "Controlled assembly of [Nb6-xWxO19] (8-x)- (x = 0-4) Lindqvist ions with (amine)copper complexes". *European Journal of Inorganic Chemistry* **2008**, 3286–3294 (2008). DOI: 10.1002/ejic.200800415.

[1] T. M. Anderson, M. A. Rodriguez, F. Bonhomme, J. N. Bixler, T. M. Alam, and M. Nyman. "An aqueous route to [Ta6O19]8- and solid-state studies of isostructural niobium and tantalum oxide complexes". *Journal of the Chemical Society. Dalton Transactions* **9226**, 4517–4522 (2007). DOI: 10.1039/b707636c.