

GEORGE MILTON MURRAY

Research Professor of Mechanical, Aerospace and Biomedical Engineering
Center for Laser Applications
University of Tennessee Space Institute
411 B. H. Goethert Parkway
Tullahoma, TN 37388-9700
931-393-7487

RELATED WORK AND EXPERIENCE

University of Tennessee Space Institute. August 2011 to present. Research Professor. The responsibilities of the position include, but are not limited to: graduate level teaching, performing research, soliciting external funding for research projects and directing the research efforts of graduate students.

University of Tennessee Space Institute. May 2008 to July 2011. Research Associate Professor. The responsibilities of the position include, but are not limited to: graduate level teaching, performing research, soliciting external funding for research projects and directing the research efforts of graduate students.

Johns Hopkins University Applied Physics Laboratory. August 1998 to 2004. Senior Professional Chemist. June 2004 to May 2008. Principal Professional Chemist. May 2005 to May 2008. Section Supervisor, Applied Chemistry. The responsibilities of the position include: supervision, technical consultations with laboratory clients, training of laboratory personnel, analytical methods development and research.

Johns Hopkins University. January 2001 to May 2008. Lecturer.

University of Maryland Baltimore County. July 1998 to June 2003. Adjunct Associate Professor. Directed graduate student researchers and teaching.

University of Maryland Baltimore County. July 1992 to July 1998. Associate Professor. The responsibilities of the position include, but are not limited to: undergraduate and graduate level teaching, performing research, soliciting external funding for research projects and directing the research efforts of undergraduate and graduate students.

Ames Laboratory, Ames, IA. June 1990 to June 1992. Associate Chemist. The position's primary purpose was the development of spectroscopic techniques for the determination of Special Nuclear Materials for the Nuclear Safeguards and Security Program. The analysis methods developed were based on optical techniques that utilized the selectivity afforded by extremely narrow bandwidth tunable lasers.

Oak Ridge National Laboratory, Oak Ridge, TN. September 1988 to June 1990. Research Associate. The position was to synthesize and spectroscopically investigate complexes and compounds of the lanthanides and actinides to understand the f block elements more fully. The methods used included UV/VIS, FT-IR, Laser Fluorescence, X-Ray Crystallography, and others.

University of Tennessee, Knoxville, TN. June 1986 to August 1988. Research Associate. The position was to develop and use free energy minimization computer algorithms to investigate the secondary water chemistry of nuclear power plants, under contract to the Tennessee Valley Authority.

EDUCATION

University of Tennessee, Knoxville, TN. September 1982 to June 1988. Ph.D. in analytical chemistry.

University of Tennessee, Knoxville, TN September 1979 to August 1982. Graduated with honors. B.A. in chemistry.

University of the South, Sewanee, TN. August 1971 to June 1972.

PROFESSIONAL MEMBERSHIPS AND HONORS

Who's Who in Science and Engineering, Who's Who Environmental Registry, Who's Who in America and Who's Who in the World. Member of the American Chemical Society, Society for Applied Spectroscopy, Materials Research Society and Society for Molecular Imprinting, JHUAPL Invention of the Year 1999, JHUAPL Invention of the Year Finalist 2001, JHUAPL Master Inventor 2007, JHUAPL Invention of the Year Finalist 2008, JHUAPL Hart Prize in Development.

PERSONAL DATA

Home Address: 205 Princeton Street, Tullahoma, Tennessee.

Home Telephone: (931) 563-7691

Security Clearance: Top Secret

FUNDING HISTORY

Pending:

2011-2012, \$113,382, Raptor Detection, Inc., "Development of Colorimetric Imprinted Polymers for Explosive Detection."

In Force:

2010-2013, \$606,000, Albiocore, Inc., "Soluble Molecularly Imprinted Polymers for Biomedical Applications."

Prior Recent Support:

2010-2011, \$399,000, Raptor Detection, Inc., "Development of Electro-active Polymers for Explosive Detection."

2009-2010, \$125,000, Babcock and Wilcox, "Preparation and Characterization of Molecularly Imprinted Ion Selective Electrodes for Uranyl Ion."

2007-2010, \$799,763, NSF, "IMPACT (Imprinted Polymer Array for Counterterrorism): A Simple, Low-power Approach to Explosives Detection."
2004-2009, \$877,901, National Security Agency, "Authentication of Electronics Packages."
2005-2008, \$838,339, NASA/Astrobiology Science and Technology Instrument Development (ASTID) "Astro-biological MIP Sensors."
2007-2008, \$75,000 US Army SBIR, "A Compact, Low Cost, Wearable Naphthalene Dosimeter Using Molecularly Imprinted Polymers (MIPs)."
2006-2007, \$60,000 Defense Threat Reduction Agency, "Selective Polymer for Selected Applications."
2003-2005, €10,000, North Atlantic Treaty Organization, "Collaborative Research."
2004-2005, \$200,000, Defense Threat Reduction Agency, "Selective Coatings for SPREETA Surface Plasmon Resonance Sensors Based on Molecularly Imprinted Polymer Technology."
2001-2004, \$200,000, United States Army, "Development of a Near Real Time Sensor for Chemical Warfare Agents."
2003-2004, \$526,400, United States Air Force, "Cost Effective, Near Real Time Sensors of Chemical Warfare Agent Precursor."
2001-2003, \$226,000, Office of National Drug Control Policy, "A Highly Selective and Inexpensive Sensor for Methylbenzoate as an Indicator for Cocaine based on Molecularly Imprinted Polymer Technology."
2001-2002, \$500,000, Office of National Drug Control Policy, "Catalytic Inhibition of Illicit Drug Manufacture."
2000-2001, \$50,000, Federal Aviation Administration, "Comparison of Options for Sensing Chemical Agent Releases on Commercial Aircraft."
1997-2000, \$302,000, U. S. Department of Energy, "Synthesis and Characterization of Templated Ion Exchange Resins for the Selective Complexation of Actinide Ions."

DESCRIPTION OF CURRENT RESEARCH

The techniques of molecular imprinting and sensitized lanthanide luminescence have been combined to create the basis for a sensor that can selectively measure a specific organophosphorous compound. A complex of polymerizable sensitizing ligand europium (III) and an organophosphorous compound are copolymerized in a cross-linked polymer matrix. The best coordinators are trifluoromethyl-substituted β -diketones. The best polymerization mechanism is by Reversible Addition Fragmentation Transfer polymerization. This approach is allowing the production of soluble processable imprinted materials. Analogous methodologies are currently being applied to the production of sensors for the detection and determination of drugs of abuse, explosives and meat spoilage. Drugs are measured in an analogous manner to the nerve agents while the explosives are being detected by the production of charge-transfer complexes between the explosives molecules, (acceptor) and immobilized amines (donor). Meat spoilage sensing is obtained using luminescence from a transition metal macrocyclic complex. The materials are also capable of providing highly selective binding sites to other transducers such as quartz crystal microbalance and surface plasmon resonance sensors.

An additional thrust is to develop new solid phase extractants for the removal of metal ions from environmental and wastewater and to serve as the basis for selective ion sensors. Rather than continuing to test existing extractants by an Edisonian approach in the hope that an excellent extractant may be found, we rely on chemical insights into what makes a good extractant. The

sources of these insights include coordination number, coordination geometry, ionic size, ionic shape, and thermodynamic affinity. Selectivity is obtained by providing the polymeric extractants with cavities lined with complexing ligands so arranged as to match the charge, coordination number, coordination geometry, and size of the metal ion. Using the metal ion as a template around which polymerizable monomeric complexing ligands are polymerized produces these cavity-containing polymers. The complexing ligands are ones containing functional groups known to form highly stable complexes with a specific metal ion and less stable complexes with other cations. We have developed sequestering agents for lead and uranium as well as electrochemical and optical sensors based on this approach. We are now applying this experience in selectivity toward preparing other form factors such as imprinted ion exchange resin beads.

TEACHING EXPERIENCE

Undergraduate

1. Chemistry 300, "Analytical Chemistry" with lab, 4 credits, UMBC.
2. Chemistry 302, "Physical Chemistry II," 3 credits, UMBC.
3. Chemistry 311L, "Advanced Lab," 3 credits, UMBC.
4. Chemistry 401, "Advanced Physical Chemistry," 3 credits, UMBC.
5. Chemistry 405, "Inorganic Chemistry," 3 credits, UMBC.
6. Chemistry 461/661, "Advanced Instrumental Analysis," with lab, 4 credits, UMBC.

Graduate

1. Chemistry 624, "Electro-Analytical Chemistry," 3 credits, UMCP.
2. Chemistry 662, "Analytical Spectroscopy," 3 credits, UMBC.
3. Chemistry 684, "Special Topics in Chemistry: Introduction to Polymer Chemistry," 3 credits, UMBC.
4. Chemistry 684, "Special Topics in Chemistry: Environmental Chemistry and Analysis," 3 credits, UMBC.
5. Chemical Engineering 540.427/545.427, "Introduction to Polymer Science," 3 credits, JHU.
6. Biomedical Engineering 585.626, "Biomimetics in Biomedical Engineering," 3 credits, JHU.
7. Applied Physics 615.481.31, "Polymeric Materials," 3 credits, JHU.
8. Materials Science and Engineering 576, "Special Topics in Materials Science and Engineering: Thin Films and Surface Analysis," 3 credits, UTSI.
9. Materials Science and Engineering 503, "Graduate Seminar in MS&E, Biomimetic Materials," 1 credit, UTSI.
10. Materials Science and Engineering 511, "Fundamentals of Materials Science and Engineering I," 3 credits, UTSI.
11. Materials Science and Engineering 576, "Special Topics in Materials Science and Engineering: All Things Carbon," 3 credits, UTSI.
12. Materials Science and Engineering 405, "Characterization of Materials," 3 credits, UTSI.
13. Materials Science and Engineering 512, "Fundamentals of Materials Science and Engineering II," 3 credits, UTSI.
14. Materials Science and Engineering 543, "Polymer Physics," 3 credits, UTSI.

Masters Students (thesis):

Xiangfei Zeng, "Synthesis and Characterization of Site Selective Ion Exchange Resin Templated for the Lead (II) Ion."

Amanda L. Jenkins, "The Ultra-trace Determination of Lanthanides by Luminescence Enhancement."

Sue Young Bae, "Extraction and Preconcentration of Ultra-trace Lead and Uranium Ions in Seawater and Their Determination by Photometry and Plasma Spectrometry."

Heo-Jeong Yoon, "Counter-ion Effects on the Structural Properties of Tris(oxydiaceto) Eu(III) Compounds by Laser Induced Luminescence."

Anton Bzhelyanskiy, "Uranyl Imprinted Polymers in Chemical Sensing."

Ph.D. Students (dissertation):

Xiangfei Zeng, "Metal Ion Selective Sensors Based on Molecularly Imprinted Polymers."

Amanda L. Jenkins, "Polymer Based Lanthanide Fluorometric Sensors for the Detection of Chemical Agents."

LeAnn M. Preston, "Determination of N-nitroso Compounds by Capillary Electrophoresis with Laser Fluorometric Detection."

Anael Kimaro, "Molecularly Imprinted Polymers and Fluorescent Polymers: Synthesis, Characterization and Application."

PUBLICATIONS

Not Peer Reviewed

Murray, G. M. and Southard, G. E., "Synthetic and Spectroscopic Characterization of Molecularly Imprinted Polymer Phosphonate Sensors," *Polymer Preprints*, 45(1) 535-536 (2004) Invited paper.

Murray, G. M. and Southard, G. E., "Sensors for Chemical Weapons Detection," *IEEE Instrumentation and Measurement Magazine*, 5(4) 12-21 (2002) Invited paper.

Murray, G. M. and Fish, R. H., "Chemical Slippers," *New Scientist*, 155, 35-8 (1997) Invited paper.

Patents

Murray, G. M., et al., "Method and Apparatus for Detection of Bio-aerosols," Patent # 7,830,515, November 9, 2010.

Charles, H. K. and Murray, G. M., "Authentication of Products Using Molecularly Imprinted Polymers," Patent # 7,799,568, September 21, 2010.

Southard, G. E. and Murray, G.M., "Processable Molecularly Imprinted Polymers," Patent # 7678870, March 16, 2010.

Murray, G. M., et al., "Method and Apparatus for Detection of Bio-aerosols," U. S. Patent # 7,494,769, February 24, 2009.

Murray, G. M., Uy, O. M. and Jenkins, A. L., "Polymer Based Lanthanide Luminescent Sensors for the Detection of Organophosphorus Compounds," U.S. Patent # 7,416,703, August 26, 2008.

Murray, G. M., "Polymer Based Permeable Membrane for Removal of Ions," U.S. Patent # 7,279,096, October 9, 2007.

Murray, G. M., Ko, H. W. and Southard, G. E., "Neutron Detection Based on Boron Activated Liquid Scintillation, U.S. Patent # 7,126,148, October 24, 2006.

Perry, A. S. and Murray, G. M., Fiber Optic Coupler with In Line Component, U.S. Patent # 7,118,287, October 10, 2006.

Southard, G. E. and Murray, G. M., "Process for Preparing Vinyl Substituted Beta-diketones," U.S. Patent # 7,067,702, June 27, 2006.

Murray, G. M., Cain; R. P., Carkhuff; B. G., Weiskopf; F., "Techniques for Sensing Chloride Ions in Wet or Dry Media," U.S. Patent # 7,063,781, June 20, 2006.

Schwartz, P. D., Murray, G. M., Uy, O. M., Le, B. Q., Stott, D. D., Lew, A. L., Ling, S. X., and Suter, J. J., Apparatus and Methods for Detecting Explosives and Other Substances," U.S. Patent #6,967,103, November 22, 2005.

Kelly, C. A., Murray, G. M., and Uy, O. M., "Method of Making a Polymeric Food Spoilage Sensor," U.S. Patent #6,924,147, August 2, 2005, 2005.

Murray, G. M., Arnold, B. A., and Lawrence, D. S., "Molecularly Imprinted Polymer Sensor for Explosives," U. S. Patent # 6,872,786, March 29, 2005.

Murray, G. M., Kelly, C. A., Uy, O. M. Hunter, L. H. and Lawrence, D. S., "Method of Inhibiting Methamphetamine Synthesis," U.S. Patent # 6,852,891, February 8, 2005.

Murray, G. M., "Polymer Based Permeable Membrane for Removal of Ions," U.S. Patent #6,780,323, August 24, 2004.

Murray, G. M., "Molecularly Imprinted Polymer Solution Anion Sensor," U.S. Patent #6,749,811, June 15, 2004.

Kelly, C. A., Murray, G. M., and Uy, O. M., "Polymeric Food Spoilage Sensor," U.S. Patent #6,593,142, July 15, 2003.

Murray, G. M., "Site Selective Ion Exchange Resins Templated for Lead (II) Ion and Methods and Devices for Their Use," U. S. Patent # 5,814,671, September 29, 1998.

Patent Applications Pending

Murray, G. M. et al., "Method and Apparatus for Detection of Bioaerosols," Published Application 20110049390, March 3, 2011.

Murray, G. M. et al., "Molecularly Imprinted Polymer Sensor Device," Published Application 20090197297, August 6, 2009.

Murray, G. M. et al., "Molecularly Imprinted Polymer Ion Exchange Resins," Published Application 20080264868, October 30, 2008.

Murray, G. M. et al., "Method and Apparatus for Detection of Bioaerosols," Published Application 20080254502, October 16, 2008.

Murray, G. M. and Southard, G. E., "Molecularly Imprinted Polymer Sensor Device," Published Application 20080144002, June 19, 2008.

Book Chapters

Southard, G. E. and Murray, G. M., "Molecularly Imprinted Polymer Receptors for Sensors and Arrays," in *Principles of Bacterial Detection: Biosensors, Recognition Receptors and Microsystems*, Zourob, M., Elwary, S. and Turner, A. Eds., Springer Verlag, 2010.

Southard, G. E., Van Houten, K. A., Ott, Jr., E. W. and Murray, G. M., "Synthetic and Spectroscopic Characterization of Molecularly Imprinted Polymer Phosphonate Sensors," in *Polymers and Materials for Anti-Terrorism and Homeland Defense*, ACS Symposium Series, Reynolds, J. G. and Lawson, G. E., Eds., American Chemical Society, Washington, D. C., 2008.

Murray, G. M. and Lawrence, D. S., "Hazardous Environment Monitoring," in *Chemical Weapons Convention Chemicals Analysis: Sample Collection, Preparation and Analytical Methods*, Mesilaakso, M. Ed., John Wiley and Sons, 2005.

Murray, G. M. and Southard G. E., "Metal Ion Selective Molecularly Imprinted Materials," in *Molecular Imprinting: Science and Technology*, Yan, M. and Ramstrom, O., Eds., Marcel Dekker, 2005.

Murray, G. M. and Southard, G. E., "Optical Transduction Schemes for Imprinted Polymer Sensors," in *Molecularly Imprinted Materials*, Kofinas, P., Roberts, M. J., Sellergren, B. Eds., Materials Research Society Symposium Series Volume 787, Warrendale, PA, 2004.

Murray, G. M. and Southard, G. E., "Molecularly Imprinted Ionomers," in *Molecularly Imprinted Materials-Sensors and Other Devices*, Shea, K. J., Yan, M., Roberts, M. J., Eds., Materials Research Society Symposium Series Volume 723, Warrendale, PA, 2002.

Murray, G. M. and Uy, O. M. "Ionic Sensors Based on Molecularly Imprinted Polymers," in *Molecularly Imprinted Polymers*, Sellergren, B., Ed., Elsevier, Amsterdam, 2001.

Zeng, X., Bzhelyansky, A., Bae, S. Y., Jenkins, A. L. and Murray, G. M. "Templated Polymers for the Selective Sequestering and Sensing of Metal Ions," in, *Molecular and Ionic Recognition with Imprinted Polymers*, ACS Symposium Series 703, Bartsch, R. A. and Maeda, M., Eds., American Chemical Society, Washington, D. C., 1998.

Journals (peer reviewed)

Izenberg, N. R., Murray, G. M., Van Houten, K. A., Pilato, R. S., Baird, L.M., and Levin, S. M., "Astrobiological Molecularly Imprinted Polymer Sensors," *Planetary and Space Science*, 57, 846–853 (2009).

Southard, G. E., Van Houten, K. A and Murray, G. M, "Soluble and Processable Phosphonate Sensing Star Molecularly Imprinted Polymers," *Macromolecules*, 40 (5) 1395-1400 (2007).

Southard, G. E., Ott Jr., E. W. Van Houten, K. A and Murray, G. M, "Luminescent Sensing of Organophosphates Using Imprinted Polymers Prepared by RAFT Polymerization," *Analytica Chimica Acta*, 581 (2) 202-207 (2007).

Southard, G. E., Van Houten, K. A. and Murray, G. M., "Heck Cross-Coupling for Synthesizing Metal Complexing Monomers," *Synthesis*, 2006 (15) 2475-2477 (2006).

Southard, G. E. and Murray, G. M., "Synthesis of Vinyl Substituted β -Diketones for Polymerizable Metal Complexes," *Journal of Organic Chemistry*, 70 (22) 9036-9039 (2005).

Bell, L. M. and Murray, G. M., "Selective Photo-reduction of N-nitrosamines Combined with Micellar Electrokinetic Chromatography and Laser Fluorimetric Detection," *Journal of Chromatography, B.*, 826, 160-168 (2005).

Owens, G. S., Southard, G. E., Van Houten, K. A. and Murray, G. M., "Molecularly Imprinted Ion Exchange Resin for Fe^{3+} ," *Separation Science and Technology*, 40, 2205-2211 (2005).

Kimaro, A, Kelly, L. A. and Murray, G. M., "Synthesis and Characterization of Molecularly Imprinted Uranyl Ion Exchange Resins," *Separation Science and Technology*, 40, 2035-2052 (2005).

Boyd, J. W., Cobb, G. P., Southard, G. E. and Murray, G. M. "Development of Molecularly Imprinted Polymer Sensors for Chemical Warfare Agents," *JHUAPL Technical Digest*, 25, 44-49 (2004).

Perry, A. S. and Murray, G. M., "In-line Fiber Optic Light Filter," *Applied Spectroscopy*, 57, 722-723 (2003).

Kimaro, A., Kelly, L. A., and Murray, G. M., "Molecularly Imprinted Ionically Permeable Membrane for Uranyl Ion," *Chemical Communications*, 14, 1282-1283 (2001).

Rooney, M., Roberts J. C., Murray, G. M. and Romenesko, B. R., "Advanced Materials; Challenges and Opportunities," *JHUAPL Technical Digest*, 21, 516-527 (2000).

Bae, S. Y., Southard, G. E. and Murray, G. M., "Molecularly Imprinted Ion Exchange Resin for Purification, Preconcentration and Determination of UO_2^{2+} by Spectrophotometry and Plasma Spectrometry," *Analytica Chimica Acta*, 397, 173-181 (1999).

Arnold, B. R., Jenkins, A. L., Uy, O. M. and Murray, G. M., "Progress in the Development of Molecularly Imprinted Polymer Sensors," *JHUAPL Technical Digest*, 20, 190-198 (1999).

Jenkins, A. L., Uy, O. M. and Murray, G. M., "Polymer Based Lanthanide Luminescent Sensor for the Detection of the Hydrolysis Product of the Nerve Agent Soman in Water," *Analytical Chemistry*, 71, 373-378 (1999).

Bae, S. Y., Zeng, X. and Murray, G. M., "A Photometric Method for the Determination of Pb^{2+} Following Separation and Preconcentration Using a Templated Ion Exchange Resin," *Journal of Analytical Atomic Spectroscopy*, 10, 1177-1181 (1998).

Jenkins, A. L. and Murray, G. M., "Enhanced Luminescence of Lanthanides: The Ultratrace Determination of Europium by Luminescence," *Journal of Chemical Education*, 575, 227-230 (1998).

Preston, L. M., Weber, M. L. and Murray, G. M., "Micellar Electrokinetic Capillary Chromatography with Laser-induced Fluorometric Detection of Amines in Beer," *Journal of Chromatography, B.*, 695, 175-180 (1997).

Jenkins, A. L., Uy, O. M. and Murray, G. M., "Polymer Based Lanthanide Luminescent Sensors for the Detection of Nerve Agents," *Analytical Communications*, 34, 221-224 (1997).

Murray, G. M., Jenkins, A. L., Bzhelyansky, A. and Uy, O. M., "Molecularly Imprinted Polymers for the Selective Sequestering and Sensing of Ions," *JHUAPL Technical Digest*, 18, 432-441 (1997).

Jenkins, A. L. and Murray, G. M., "Ultratrace Determination of Luminescent Lanthanides," *Analytical Chemistry*, 68, 2974-2980 (1996).

Zeng, X. and Murray, G. M. "Synthesis and Characterization of Site Selective Ion Exchange Resins Templated for Lead(II) Ion," *Separation Science and Technology*, 31, 2403 (1996).

Stump, N. A., Schweitzer, G. K., Murray, G. M. and Peterson, J. R., "Luminescence Detection of Cation Exchange in $\text{Na}_3[\text{Eu}(2\text{-6, Pyridine-dicarboxylato)}_3]$," *Journal of Luminescence*, 60, 104-107 (1994).

Stump, N. A., Murray, G. M., Del Cul, G. D., Haire, R. G., and Peterson, J. R., "Anti-Stokes Luminescence from the Trihalides of Cm-248," *Radiochimica Acta*, 61, 129-136 (1993).

Stump, N. A., Pesterfield L. L., Schweitzer, G. K., Peterson, J. R. and Murray, G. M. "Synthesis and Spectral Study of Several Solid $M_3[Eu(2-6, \text{Pyridinedicarboxylate})]$ Salts ($M= Li^+, Na^+, K^+, Rb^+, Cs^+, NH_4^+$, and Pyridinium $^+$)," *Spectroscopy Letters*, 28, 1421-8 (1992).

Murray, G. M., Weeks, S. J., and Edelson, M. C., "Determination of Uranium Isotopes in a Complex Matrix by Optical Spectroscopy," *Journal of Alloys and Compounds*, 181, 57-62 (1992).

Vera, J. A., Murray, G. M., Weeks, S. J., and Edelson, M. C., "Isotopic Abundance Determination by Inductively Coupled Plasma High-resolution Laser Excited Atomic and Ionic Fluorescence," *Spectrochimica Acta*, 46B, 1689-1700, (1991).

Zamzow, D., Murray, G. M., D'Silva, A. P., and Edelson, M. C., "High-Resolution Optical Emission Spectroscopy of Uranium Hexafluoride in the Argon Afterglow Discharge," *Applied Spectroscopy*, 45, 1318-1322 (1991).

Murray, G. M., Del Cul, G. D., Nave, S. E., Chang, C-T. P., Haire, R. G., and Peterson, J. R., "Anti-Stokes Luminescence of Selected Actinide(III) Compounds," *European Journal of Solid State and Inorganic Chemistry*, t., 28, 105-8 (1991).

Del Cul, G. D., Murray, G. M., Nave, S. E., Chang, C-T. P., Begun G. M., and Peterson, J. R., "Luminescence, Absorbance and Raman Studies of Europium Oxychloride at Various Pressures," *European Journal of Solid State and Inorganic Chemistry*, t., 28, 155-8 (1991).

Young, J. P., Murray, G. M., Ensor, D. D., and Vick, D. O., "Luminescence Spectrum of Trivalent Terbium Ions Adsorbed on a Single Resin Bead," *Applied Spectroscopy*, 45,134-5, (1991).

Murray, G. M., Sarrio, R. V., and Peterson, J. R., "The Effects of Hydration on the Fluorescence Spectra of Trisodium Tris(2,6-pyridinedicarboxylato)europium(III) Compounds," *Inorganica Chimica Acta*, 176, 223-240, (1990).

Murray, G. M., Sarrio, R. V., and Peterson, J. R., "The Correlation of Raman Phonon and Eu(III) Ion Luminescence as a Probe of Structure in Trisodium Tris(2,6-pyridinedicarboxylato)lanthanide(III) Compounds," *Applied Spectroscopy*, 44, 1647-53, (1990).

Murray, G. M., Del Cul, G. D., Begun, G. M., Haire, R. G., Young, J. Y., and Peterson, J. R., "Anti-Stokes Luminescence of $^{248}\text{Curium(III)}$ bromide," *Chemical Physics Letters*, 168, 473-7, (1990).

Murray, G. M., Schweitzer, G. K., and Heacker, F. K., "Corrosion System Modeling Under Nonstandard Conditions Using Microcomputer Programs for Free Energy Minimization," *Corrosion*, 46, 95-9, (1990).

Murray, G. M., Pesterfield, L. L., Stump, N. A., and Schweitzer, G. K., "The Effects of Some Inorganic Counter-cations on the Fluorescence Spectra of the Tetrakis(1-phenyl-1,3-butanediono)europium(III) Ion", *Inorganic Chemistry*, 28, 1994-8, (1989).

Dissertation, Murray, G. M., Rare Earth Containing Complex Compounds for the Determination of Inorganic Ions.

Murray, G. M., Schweitzer, G. K., and Heacker, F. K., "Corrosion System Modeling Using Microcomputer Programs for Free Energy Minimization," *Corrosion Science*, 28, 923-33, (1988).

Murray, G. M., and Sepaniak, M. J., "HPLC Laser Fluorometric Determination of Amines in Beer," *Journal of Liquid Chromatography*, 6, 931-8, (1983).

RECENT PRESENTATIONS

Invited Presentations

Murray, G. M., "Ion Sensors Based on Ionic Imprinting of Polymers," University of Tennessee, Knoxville, September 28, 2010.

Murray, G. M., "Chemical Recognition Using Ionic Imprinting," Winston Salem State University, May 26, 2010.

Murray, G. M., "Molecular Recognition Using Molecular Imprinting," Austin Peay State University, March 20, 2010.

Murray, G. M., "Chemical Recognition Using Molecular Imprinting," University of Tennessee, Knoxville, February 9, 2010.

Murray, G. M., "Ionic Imprinting of Conductive Polymer Films," University of Tennessee Space Institute, October 22, 2009.

Murray, G. M., "Molecularly Imprinted Polymers for Sensing and Sequestration," University of Tennessee Space Institute, October 8, 2008.

Murray, G. M., "Chemical Recognition Using Molecular Imprinting," Vanderbilt University, September 29, 2008.

Murray, G. M., "Chemical Recognition for Illicit Substance Detection Using Molecular Imprinting," University of Tennessee Space Institute, October 8, 2007.

Murray, G. M., "Chemical Recognition for Illicit Substance Detection Using Molecular Imprinting," Middle Tennessee State University, April 2, 2007.

Murray, G. M., "Chemical Recognition for Illicit Substance Detection Using Molecular Imprinting," University of North Alabama, March 23, 2007.

Murray, G. M., "Molecularly Imprinted Polymer Sensors for Food Safety Applications" 2005 FDA Science Forum, Washington D. C., April 27-28, 2005.

Murray, G. M. and Southard G.E., "Synthetic and Spectroscopic Characterization of Molecularly Imprinted Polymer Phosphonate Sensors," 227th National Meeting of the American Chemical Society, March 28-April 3, 2004.

Murray, G. M., "Optical Transduction Schemes for Molecularly Imprinted Polymer Sensors," paper G5.1, 2003 Fall Meeting of the Materials Research Society, Boston, MA, December 1-5, 2003.

Murray, G. M., "Molecularly Imprinted Polymer Sensors," Symposium MI 402, 2003 Meeting of the Association for the Advancement Of Medical Instrumentation, Long Beach, CA, June 14-17, 2003.

Murray, G. M., "Molecularly Imprinted Ionomers," paper M3.3, 2002 Spring Meeting of the Materials Research Society, San Francisco, CA, April 1-5, 2002.

Murray, G. M., "Introduction and Overview of Optical Bio-diagnostics," paper 167, 29th Annual Meeting of the American Society for Photobiology, Chicago, IL, July 7-12, 2001.

Lawrence, D. S. and Murray, G. M., "Molecularly Imprinted Polymer Sensors," paper 168, 29th Annual Meeting of the American Society for Photobiology, Chicago, IL, July 7-12, 2001.

Murray, G. M., Van Woert, Jr., H. and Uy, O. M., "Portable Sensor for Illicit Cocaine Based on a Molecularly Imprinted Polymer," 2001 ONDCP International Symposium, San Diego CA, June 25-28, 2001.

Murray, G. M., Arnold, B. R., Kelly, C. A. and Uy, O. M., "Imprinted Polymers Sensors for Contamination Detection," Proceedings of SPIE. 4206: 131-139. (Photonic Detection and Intervention Technologies for Safe Food, November 5-6, 2000, Boston, USA).

Murray, G. M., "Characterization of Imprinted Polymer Sensors," Gordon Conference on Bioanalytical Sensors, Proctor Academy, Andover, New Hampshire, July 23-28, 2000.

Kimaro, A., Kelly, L. A. and Murray, G. M. "Uranyl Ion Imprinted Polymer: Synthesis and Application to Sensors and Ionically Permeable Membrane Preparation," Second Environmental Management Science Program National Workshop, Atlanta, Georgia, April 24-27, 2000.

Murray, G. M., "Illegal Substance Detection Employing Molecularly Imprinted Polymers," Gordon Conference on Illicit Substance Detection, Salve Regina University, Newport Rhode Island, August 8-13, 1999.

Murray, G. M., "Molecularly Imprinted Polymers for Selective Sequestering and Sensing," Colloquium, U. S. Army Edgewood Research, Development and Engineering Center, Edgewood MD, March 30, 1999.

Murray, G. M. and Uy, O. M., "Use of Molecularly Imprinted Polymer Technology for Drug Sensing," 1999 CTAC International Symposium, Washington, D. C., March 8, 1999.

Murray, G. M., "Imprinted Polymers for the Selective Sequestering and Sensing of Metal Ions," Center for Environmental Biotechnology Seminar Series, Lawrence Berkeley National Laboratory, May 26, 1998.

Zeng, X. and Murray, G. M., "Templated Polymers for Selective Sequestering and Sensing of Metal Ions," 213th National Meeting of the American Chemical Society, April 13-17, 1997.

Other presentations

Vu, M., Terekhov, A., Murray, G., Schweizer, S., Weber, R., Johnson, C., Johnson, J., "A Secondary Ion Mass Spectroscopy (SIMS) and Mössbauer Study of Modified ZBLAN Glasses," The American Ceramic Society, Glass and Optical Materials Division Meeting, Corning, New York, May 2010.

Rajput, D., Costa, L., Lansford, K., Terekhov, A., Murray, G., and Hofmeister, W. "Transition Metal Coatings on Graphite Via Laser Processing." 28th International Congress on Applications of Lasers and Electro-Optics, Laser Institute of America, Orlando, Florida, USA, 2009.

Baird, L. M., Levin, S. M., Van Houten, K. A., Pilato, R. S., Murray, G. M., Izenberg, N. R. "Detection of Biological Molecules Via Molecularly Imprinted Polymers Coupled with Surface Plasmon Resonance" Abstract for the 38th LPSC Lunar and Planetary Science Conference, Houston TX, March, 2008.

Lawrence, D. S., Hofstra, A. A., Kozlowski, M. V., Murray, G. M., Van Gieson, E. J., Vertes, R. F., Lesho, J. C., "Environmental Characterization of Selected Ports of Entry for the Identification of Background Interferants," Presented at the 2008 Annual Chemical and Biological R&D Technologies Conference, San Antonio, TX, January 2008.

Van Houten, K. A., Pilato, R. S., Murray, G. M. Izenberg, N. R. "Affinity Resins for Biomarker Amine Detection" Abstract for the 37th LPSC Lunar and Planetary Science Conference, Houston TX, March, 2007.

Strauch, L. R., Van Houten, K. A. and Murray, G. M., "A Color Changing Selective Sensor for Biogenic Amines," ACS Middle Atlantic Regional Meeting, Hershey, PA, June 4-7, 2006.

Kimaro, A. and Murray, G. M. "Synthesis and Characterization of Templated Ion Exchange Resins for the Selective Complexation of Actinide Ions," Abstract No. 2315P, Pittsburgh Conference, Orlando, Florida, March 7-12, 1999.

REFERENCES

Available on request.