CARL C. NESBITT

Associate Professor and Newmont Co-Chair
Department of Mining Engineering
Mail Stop 173
University of Nevada, Reno
Reno, Nevada 89557-0173
E-mail: carln@unr.edu
Phone: (775) 784-8287

Education:

University of Nevada, Reno
Reno, Nevada, 1990, Ph.D. in Metallurgical Engineering
Dissertation: *A Study of the Chlorination of Gold: The Effect of Nascent Chlorine, Mechanism Determination, the Role of Sulfide Minerals and Carbon, and the Effect of Multivalent Chloride Salts*

University of Michigan
Ann Arbor, Michigan, 1989, M.S.E. in Chemical Engineering.
Report: *Coal Stabilization using Hydrocolloids*

University of Nevada, Reno
Reno, Nevada, 1985, M.S. in Metallurgical Engineering
Thesis: *A Study of the Effect of Using Thiourea as a Sulfide Donor for Metal Sulfide Precipitation from Waste Waters*

University of Nevada, Reno
Reno, Nevada, 1980, B.S. in Chemical Engineering

Experience:

2009 – Present	Associate Professor-Newmont Co-chair, Department of Mining Engineering, University of Nevada, Reno, Nevada
2007 – 2009	Research Associate Professor, Chemical and Metallurgical Engineering Dept., University of Nevada, Reno, Nevada
2002 – 2009	Associate Professor, Department of Chemical Engineering, Michigan Technological University, Houghton, Michigan
2001 – 2002	Associate Professor, Department of Mining and Materials Processing Engineering, Michigan Technological University, Houghton, Michigan
1996 – 2001	Associate Professor, Department of Metallurgical and Materials Engineering, Michigan Technological University, Houghton, Michigan
1990 – 1996	Assistant Professor, Department of Metallurgical and Materials Engineering, Michigan Technological University, Houghton, Michigan
1988 – 1990	Research Fellow and Lecturer, Department of Chemical and Metallurgical Engineering, University of Nevada, Reno, Nevada
1986 – 1988	Research and Teaching Fellow, Department of Material Sciences and Engineering, University of Michigan, Ann Arbor, Michigan
1985 - 1986	Research Fellow, Department of Chemical Engineering, University of Michigan, Ann Arbor, Michigan
1984 – 1985	Research Fellow, Department of Chemical and Metallurgical Engineering, University of Nevada, Reno, Nevada
1980 – 1983	Metallurgical Engineer, Nevada Moly Operation, Anaconda Minerals Company, Tonopah, Nevada

Research Interests:

Activated Carbon Materials, Energy Storage, Nuclear Materials and Spent Nuclear Fuel Recycle using Molten Salts, Ceramics, Powder Metallurgy, Supply and Demand of Coal, Oil and Natural Gas, Renewable

Energy Usage, Oxidation-Reduction Chemistry, Electrochemistry, Hydrometallurgy, Mineral Processing Technology, Water Treatment, Metal Precipitation Processes, Materials Processing Technology.

List of Courses Taught:

Undergraduate

Mineral Processing Unit Operation: Applied particle technology as applied to solid-solid separations, crushing and grinding, solid-liquid separations, mineral processing strategies, environmental remediation of solids.

Mineral Processing Design: Capstone engineering course to develop technical and economic feasibility of a solid material. Minerals, scrap, wastes, etc. were used to develop modeling skills for determining processing strategies, technical feasibility and economic analysis of new plants and plant modifications.

Unit Operations Design in Mineral Processing: A 6-week summer capstone design course specifically designed for the students to develop flow sheets, and perform laboratory tests for treating a material. The course culminated with the design and construction and operation of a pilot plant capable of processing several tons of the material. The course was intended to develop hands-on, continuous processing skills from the individual courses of their curricula.

Hydrometallurgy and Pyrometallurgy: Processes for recovering metal from aqueous solutions and solid materials, including remediation and industrial applications. The course includes high temperature processing as well as water treatment technologies, such as ion exchange, solvent extraction, etc.

Instrumentation and Control: Applying control theory, pneumatics and electronic control loop processing as applied to crushing, milling and concentration processes

Chemical Engineering Design: Capstone engineering course which covers the optimization of an existing facility, risk analysis, economic analysis and greenfield design of various chemical processes

Introduction to Chemical Engineering II: Unit Operations of basic chemical operations, including pumping, evaporation, distillation, adsorption, liquid-liquid extraction and membrane technologies

Introduction to Materials Science: Fundamental courses of materials engineering including crystallography, phase transformations, metal-, ceramic-, polymer- and composite-materials properties, manufacture, corrosion, etc.

Sustainable Energy: Current techniques for generation of power using fossil fuels and nuclear fuels, with an introduction to economic analysis of various power generation strategies. The course emphasized renewable energy sources, and the variety of fuels for transportation and power generation.

Graduate

Advanced Corrosion Engineering: Advanced course on the chemistry, mechanisms and laboratory technique and analysis of metal corrosion.

Environmental Chemistry of Metals: Advanced course on the chemistry of metals in aqueous streams, unit operations and unit processes for remediation of metal-bearing water. Inorganic chemistry and some economics of processing were introduced.

Surface Chemistry I: Advanced course focusing on the physical chemistry of liquid-liquid and vapor-liquid interfaces.

Surface Chemistry II: Advanced course focusing on the physical chemistry of solid-liquid interfaces and solid-liquid-vapor interfaces

Advanced Mathematics for Chemical Engineers: Advanced engineering calculus. Methods for solving systems of equations, ordinary- and partial-differential equations, numerical analysis, Laplace transforms.

CARL C. NESBITT

Patents:

Monolithic Carbon Material—currently assigned to Reticle Inc., Los Altos, California

U.S. Patent No. 6,350,520: C. C. Nesbitt and X. Sun, "Consolidated Amorphous Carbon Materials, Their Manufacture and Use", Issued February 26, 2002.

U.S. Patent No. 6,511,645: C. C. Nesbitt and X. Sun, "Consolidated Amorphous Carbon Materials, Their Manufacture and Use", Issued January 28, 2003.

U.S. Patent No. 6,544,648: C. C. Nesbitt and X. Sun, "Consolidated Amorphous Carbon Materials, Their Manufacture and Use", Issued April 8, 2003.

U.S. Patent No. 6,787,235: C. C. Nesbitt and X. Sun, "Consolidated Amorphous Carbon Materials, Their Manufacture and Use", Issued September 7, 2004.

Australia Patent No. 755,842: **C.C. Nesbitt** and X. Sun, "Consolidated Amorphous Carbon Materials, Their Manufacture and Use", Standard Patent Granted April 7, 2005.

PCT Patents Pending: Canada, UAE, Europe, China, Japan, Indonesia and Mexico.

Ferric Ion Generator ("Stand-Alone Automated Bioreactor for Ferric Ion Generation"--SAAB-FIG)—currently assigned toFerritech Inc., Los Altos, California

U.S. Patent No. 6,043,022: D. R. Lueking and **C. C. Nesbitt**, "Apparatus for the Generation and Use of Ferric Ions", Issued March 28, 2000.

U.S. Patent No. 5,827,701: D. R. Lueking and **C. C. Nesbitt**, "Method for the Generation and Use of Ferric Ions", Issued October 27, 1998.

Republic of South Africa Patent No. 97/4368: Board of Control of Michigan Technological University (Donald R. Lueking and **Carl C. Nesbitt**, Inventors), "Apparatus and method for the generation and use of ferric ions", October 28, 1998.

Australian Patent No. 725,634: Board of Control of Michigan Technological University (Donald R. Lueking and **Carl C. Nesbitt**, Inventors), "Apparatus and method for the generation and use of ferric ions", Accepted Journal Date October 19, 2000.

Mexico Patent No. 201,601: Board of Control of Michigan Technological University (Donald R. Lueking and **Carl C. Nesbitt**, Inventors), "Aparato Y Metodo Para La Generacion Y Uso De Iones Ferricos", Granted April 27, 2001.

Peru Patent No. 2595: Board of Control of Michigan Technological University (Donald R. Lueking and Carl C. Nesbitt, Inventors), "Aparato Y Metodo Para La Generacion Y Uso De Iones Ferricos", Granted August 29, 2002.

German Patent No. DE 697 15 299 T2: Board of Control Michigan Technological University (Donald Lueking and Carl C. Nesbitt, Inventors) "Verfahren zur Erzeugung und Verwendung von mittels Bakterien produzierten Eissen (III)-lonen." Granted September 11, 2002.

European Patent No. 808,910: Board of Control Michigan Technological University (Donald Lueking and Carl C. Nesbitt, Inventors) "Method for the generation and use of ferric ions produced by bacteria", Granted September 11, 2002.

United Kingdom Patent No. **808,910**: Board of Control of Michigan Technological University (Donald R. Lueking and **Carl C. Nesbitt**, Inventors), "Apparatus and method for the generation and use of ferric ions", Accepted Journal Date 2003.

Indonesia Patent No. ID 0011302: Board of Control of Michigan Technological University (Donald R. Lueking and **Carl C. Nesbitt**, Inventors), "Peralatan Dan Metoda Untuk Pembangkitan Dan Penggunaan Ion-Ion Ferri", Issued August 5, 2003.

Patents Pending: Canada (Appl. No. 2205151), Chile (Appl. No. 960-97), Brazil (Appl. No. P-19703302.2), and Argentina (Appl. No. P-970102149).

CARL C. NESBITT

List of Relevant Publications:

1. Rahman, M.S., Raja, K.S., **Nesbitt, C.** and Misra, M. "Characterization of High Temperature Deformation Behavior of INCONEL 617 Using Scanning Kelvin Probe Force Microscopy", *Mechanics of Materials*, 41(2009), pp. 261-270.
2. **Carl C. Nesbitt**, "Reticle Carbon: Electrode Material for Ultracapacitors", available for download at http://Ultracapacitors.org
3. **Carl C. Nesbitt**, "Use of Reticle Carbon in Supercapacitors", *Clean Technology2008 Technical Proceedings*, June, 2008, pp. 463-466, ISBN 978-1-4200-8502-0.
4. Rahman, M.S., Raja, K.S., **Nesbitt, C.** and Misra, M. "Investigation of High Temperature Deformation Properties of Alloy 617 Using Scanning Kelvin Probe Force Microscope", *Transactions of the American Nuclear Society*, 2008 (97), pp. 685-685.
5. **Carl C. Nesbitt**, "Waste Reduction in Metals Manufacturing", Chapter 2 of *Environmentally Conscious Materials and Chemical Processes*, Myer Kurtz, Editor, John Wiley & Sons, pp. 33-58, March, 2007 (ISBN: 978-0-471-73904-3).
6. Nicholas R. Ballor, **Carl C. Nesbitt**, and Donald R. Lueking, "Recovery of Scrap Iron Value Using Biogenerated Ferric Iron", *Biotechnology and Bioengineering*, Volume 93, Number 6 (April, 2006), pp. 1089-1094.
7. Donald Lueking and **Carl C. Nesbitt**, "Ferric Iron Biogeneration: An Extreme Approach," *SIM News: The Official News Magazine of the Society for Industrial Microbiology*, Vol. 54, No. 1, (January/February 2004), pp. 4-9.
8. **Carl C. Nesbitt** and Donald R. Lueking, "The Recovery of Copper from Spent Bed Material Using Biologically Regenerated Ferric Leach Solutions—the SAAB-FIG Process", invited paper in *Silicon for the Chemical Industry IV*, Øye, Rong, Nygaard, Schüssler and Tuset, Eds., Loen, Norway, June 17-21, 2002.
9. **C.C. Nesbitt** and D.R. Lueking, "The Use of Separate Unit Processes and Indirect Leaching for the Recovery of Copper from Chalcocite and Chalcopyrite," *International Congress on Mineral Processing and Extractive Metallurgy*, The Australasian Institute of Mining and Metallurgy (2000), pp. 249-252.
10. T. Wahyudi, T.J. Bornhorst, and **C. Nesbitt**, "A Comparative Study of Cyanide and Bromine Recovery of Gold from a Roasted Osikonmäki Gold Ore, Finland", in *Geological setting and characteristics of the tonalite-hosted Paleoproterozoic Gold Deposit of Osikonmäki, Ranasalmi, Southeastern Finland*, O. Kontoniemi and P. Nurmi, Eds., Geological Survey of Finland, Special Paper 25 (1998), pp. 111-119.
11. John L. Uhrie, James I. Drever, Patricia J.S. Colberg and **Carl C. Nesbitt**, "In Situ Immobilization of Heavy Metals Associated with Uranium Leach Mines by Bacterial Sulfate Reduction," *Hydrometallurgy*, *43* (1996), pp. 231-239.
12. Sue Xue and **Carl C. Nesbitt**, "Process Development for Recovery of Lead as Lead Monoxide From Lead-Bearing Waste", *Second International Symposium on Extraction and Processing for the Treatment and Minimization of Wastes*, V. Ramachandran and **C. C. Nesbitt**, Eds., The Minerals, Metals and Materials Society, Warrendale, PA, 1996.
13. J.A. Willemin, **C.C. Nesbitt**, G.R. Dewey, and J.F. Sandell, "Flow Injection Analysis of MWC Fly Ash Leaching Characteristics," *The Journal of the Air and Waste Management Association*, Vol. 45, November (1995), pp. 871-876.
14. Stanley J. Vitton, **Carl C. Nesbitt** and Leon Y. Sadler, "Soil Particle-Size Analysis Using X-ray Absorption", 75th Annual Meeting of the Transportation Research Board of the National Research Council, January 7-11, 1996, Washington, D.C. (Published in February, 1996 issue of *Journal of the Transportation Research Board of the National Research Council*).
15. **Carl C. Nesbitt** and Sui Xue, "Recycling of Base Metals from Metal Wastes of Brass Foundries", in *Treatment and Minimization of Heavy Metal Containing Waste*, The Minerals, Metals and Materials Society of the AIME, Warrendale, PA, pp. 43-56, 1995. (Presented at TMS-AIME Annual Meeting in Las Vegas, NV, February, 1995).
16. **C.C. Nesbitt** and T.E. Davis, "Removal of Heavy Metals from Metallurgical Effluents by the Simultaneous Precipitation and Flotation of Metal Sulfides Using Column Cells", *Extraction and Processing for the Treatment and Minimization of Wastes*, TMS-AIME, Warrendale, PA, pp. 331-342, 1994. (Presented at TMS-AIME Annual Meeting in San Francisco, CA, February, 1994.)

CARL C. NESBITT

List of Research Clients:

U.S. DoE (Current): Providing fundamental studies for the recycle of spent nuclear fuel rods using molten salt electrochemical reduction. The study includes determining the thermodynamic parameters, crucible material selection and novel methods for encapsulating high level radioactive salt compounds.

U.S. DoE (Current): Advising students and researchers on a project to produce hydrogen from solar energy. The project utilizes novel manufacturing techniques to produce advanced photoelectrochemical electrodes for the optimal conversion of solar energy into electrochemical reduction of water into hydrogen and oxygen.

U.S. DoE (Current): Testing of the corrosion of materials for GenIV nuclear power plants. The study included production of a laboratory scale liquid sodium cooling loop to test various concentrations of dissolved oxygen and the effect on structural materials for the next generation nuclear power plants.

U.S. DoE: Managed a project to investigate the corrosion behavior of Alloy 22. This material was considered to encase the nuclear waste to be deposited in the Yucca Mountain Nuclear Repository. Cathodic and anodic polarization tests, and rotating disk tests were conducted in a variety of electrolytes (typical to the region), and temperatures.

Wharf Resources: Study the application of Reticle Carbon to the remove selenium, cyanide or other ions from process water of a gold mining operation. Developed and constructed a laboratory and pilot-scale cell for the removal of selenium from waste water.

Dow Corning: Study the application of SAAB-FIG generated leach solutions for the removal and recovery of copper from spent silicon materials. Determined the preliminary and final design and economics of a plant which used ferric-rich solutions to dissolve and recover copper from waste materials.

Newmont Metallurgical Services: (two projects)

(1) Developed, engineered and optimized a process to treat and recycle the lead from fire assay wastes. A full-scale facility is currently in operation.

(2) Conducted preliminary study on the efficacy of using a precipitation process to treat the acid rock drainage from their Batu Haiju mine in Indonesia.

Copper Range Company: Developed a biological process for *in situ* copper leaching plant. The plant shut down before pilot scale plant could be constructed. The process was patented in the U.S. and internationally (SAAB-FIG).

Barrick Goldstrike Mine: Used the biological process for leaching experiments with refractory gold ores. Developed laboratory experiments that Barrick personnel could use to evaluate autoclave process parameters.

Kohler and U.S. EPA: Developed, tested and optimized a process for the removal and recovery of lead from brass wastes.

Michigan Great Lakes Protection Fund: Developed and optimized a process to remove mercury from copper concentrates prior to smelting.

Work Experience:

Anaconda Minerals Company: Metallurgical engineer for a 30,000-tpd molybdenite concentrator and leaching facility. Performed operational optimization and was the engineer for three construction projects in the three years on the job.

United States Bureau of Mines: Research associate working on several projects, including the isolation and recovery of heavy minerals from sand and gravel plants of the Pacific Northwest, and the recovery of scheelite by flotation using fatty acid collectors.

CARL C. NESBITT

List of Consultant Clients and Company Associations:

Reticle Inc. (current client): Founder, President and CEO of a California-based startup company that manufactures, produces, and engineers systems using a unique, high surface area activated carbon material. The company was established in 1997, and has lead to cooperative studies in enhanced ion removal from drinking water and wastewater and the recovery of metal value from dilute streams. Recently, we began using the material in advanced ultracapacitors for storing solar and wind energy for use during peak demand. Work has also begun to use Reticle Carbon as a catalyst for the capture of CO_2 for the direct reduction into useful fuels, such as CO and methanol. A proposal submitted to DoE SBIR is in review.

Altos Management Partners (current client): A California market strategy consulting company that produces world-market modeling software for oil, natural gas, electricity and coal. I have helped with several of their clients, including:

- Chevron
- Calpine
- Shell Oil
- Black & Veatch

My most recent involvement has been in the quantification of petroleum reserves and production rates in all regions of the world. Also, I have been involved with the modeling of the mining, delivery, gasification and desulfurization of coal. I have amassed the supply information for a comprehensive, world-model of copper and coal mining.

Ferritech Inc. (current client): Founder of a California-based startup company that tests and applies ferric iron that is biologically generated using the SAAB-FIG technology developed and patented at MTU. The company was established in 2003 in partnership with Dr. Donald Lueking, co-inventor of the process.

SDSU Foundation, Energy Innovations Small Grant (EISG) Program, California Energy Commission (current client): Reviewer of grants to the CEC for innovative energy projects. I have reviewed several renewable energy projects using a variety of sources rangin from tidal current to wind, and solar. I have also been asked to review water treatment projects as part of this duty.

EverClear Solutions, LLC: Evaluate and design novel process for the recovery of metals from acid-rock drainage and pit waters.

Plaza-Integrated Industries Ltd.: Design and lab-scale evaluation of processes for recovering metal from ores and metal wastes.

SaskWater: Studied the application of Reticle Carbon in the removal of ions from drinking water from small municipalities of Saskatchewan. A side benefit of this project was proof that we could produce potable water using solar energy, which could be stored in units until needed. Worked in conjunction with Dr. Gordon Sparks of University of Saskatchewan.

Peninsula Copper Industries Inc.: Designing the experimental protocol for developing new process streams in a copper recycling operation. Involved in the engineering economic analysis to determine future plant operation strategy and product lines.

Barrick Gold Company: Reviewed data to help determine the factors affecting the operation of the company's autoclaves. Process changes based on economic evaluations were provided to the company as part of the contract.

Custom Heat Treat: Developed a recycle strategy to recover more that 90% of the company's waste barium chloride salts. The process was implemented based on the economic and process analysis that I provided.