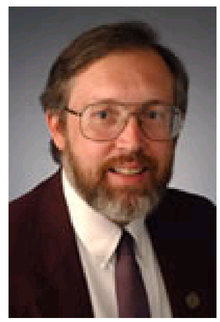
James T. Spencer

Laura J. and L. Douglas Meredith Professor, Chemistry



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Research Interests

Inorganic chemistry; organometallic chemistry; materials chemistry and solid state science; new sensor development, renewable energy systems (photovoltaic), forensic science

Education

- B.A., 1978, State University of New York at Potsdam
- Ph.D., 1984, Iowa State University of Science and Technology
- Postdoctoral Research Fellow, 1984-1986, University of Virginia

Honors & Awards

Chancellor's Citation for Excellence, 2013.
Distinguished Achievements in Boron Science, 2000
Excellence in Teaching Award, University College, Syracuse University, May 2009
Laura J. and L. Douglas Meredith Professor, 2009 to present
Member, New York Academy of Science, 2012 to present and American Academy of Forensic Science, Criminalistics Division, 2010 to present.

Courses

- CHE 113: Forensic Science
- CHE 106: General Chemistry
- FSC 406/606: Advanced Forensic Science
- FSC 632: Scientific Research and Career Resources in Forensic Science

Research Focus

The study of polyhedra, many-faced solids, has long intrigued and fascinated scientists and philosophers. Plato first described a series of five "pure" polyhedral bodies from which Archimedes later elegantly derived 13 semi-regular polyhedra. The field of cluster chemistry, however, most closely ties together the abstract study of pure polyhedra with the physical and chemical world. In particular, cluster chemistry may be thought of as the practical bridge between small molecule behavior, with more localized bonding, and that of extended solid arrays, with extensively delocalized electronic structures.

One aspect of our work focuses upon the development of new solid state boron-based materials as thin films, nanoparticles, and nanotubes. These materials display an enormous range of physical and chemical properties that have direct application to many areas. We have recently discovered several new chemical pathways for the formation of thin films of metal borides, along with the first-reported pathways for the fabrication of boron-based nanotubes and nanorod structures. These unique structures, for instance, are readily prepared, are remarkably uniform, and display very large aspect ratios.

In the second area of our work, we are developing new generations of sensors with extreme response and selectivity properties. These are based upon the use of piezoelectric solid state and functionalized solid state systems, including QCM-based devices.

In a third area of our work, we are exploring the chemistry of main group polyhedral clusters. The field spans the boundaries of traditional areas of inorganic, organometallic, and materials chemistry. Specifically, our research has focused upon the study of polyhedral based as new nonlinear optical compounds, the photochemical reactions of clusters, and the use of cluster and rigid molecules as molecular building blocks in the directed formation of nanoscale architectures.
Main group and organometallic clusters have presented considerable challenges to synthetic, structural, materials and theoretical chemists since their discovery nearly ninety years ago. The quest for a detailed understanding of the bonding and structural relationships of these species has led to an understanding of some of the fundamental chemistry of molecular polyhedra in general.

Recently, we have begun work on the development of new generations of photovoltaic and hydrogen storage systems. In our photovoltaic work, we have begun to explore new chemical designs to overcome the considerable obstacles current limiting existing devises. Our approach, that has not been thus far explored, involves the use of a multi-component system incorporating an electron reservoir design. In this design, an electron reservoir macrocyclic system is coupled with a sensitizer, such as a dye molecule, and a semiconductor. In this arrangement, a photon can cause a one-electron photoreduction of the reservoir, with the electron coming initially from an attached dye or donor, and subsequently causing electron transfer from the reservoir to the semiconductor network. Several types of electron reservoirs are being investigated, including carborane macrocycles and donor-bridge-acceptor systems. These systems provide a significant degree of potential chemical tailoring of electronic properties that may make them particularly interesting as a new generation of efficient photovoltaic cells.

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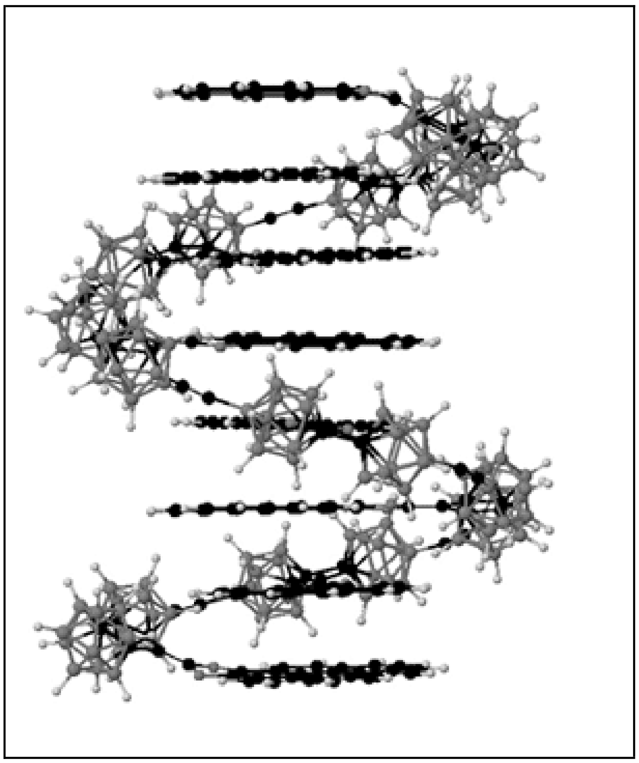
Chemical vapor deposition (CVD) reactor



Proposed helical structure for nonoscale boron
cluster assembly

Selected Publications

- Schlereth, F.H.; Mahabalagiri, A.K; Khadeer, A.; McLoed, T.; Spencer, J.T.; Sweder, K.S. "Frequency Measurement

for QCM Applications" Proc. IEEE (ICIC 2015), **2015**.

- Ma, Pei; Spencer, James T. "Non-covalent Stabilization and Functionalization of Boron Nitride Nanosheets (BNNSs) by Organic Polymers: Formation of Complex BNNSs-containing Structures." *J. Materials Science* **2015**, *50(1)*, 313-323.
- Ma, Pei; Smith, Tiffany M.; Zubieta, Jon; Spencer, James T. "Synthesis of Alkoxy Derivatives of the 10-Vertex Manganadecaborane [*nido*-6-Mn$(CO)_3B_9H_{13}$][NMe_4]" *Inorg. Chem. Commun*. **2014**, *46*, 223-225.
- Taylor, J.; Vargas, W.; Torvisco, A.; Ruhlandt-Senge, K.; Spencer, J. T. "Synthesis and Characterization of Cyano-Substituted Carborane-based Compounds. Molecular Structure of [1-(4-C_7H_7)-12-(C_5H_3-3-(CN)-3,4-$(CH_3)_2$)-$C_2B_{10}H_{10}$]." *Dalton Trans.* **2011***, 40*, 20585-91.
- Kher, S. S.; Romero, J.V.; Caruso, J.D.; Spencer, J. T. Chemical Vapor Deposition of Metal Borides. 6. The Formation of Neodymium Boride Thin Film Materials from Polyhedral Boron Clusters and Metal Halides by Chemical Vapor Deposition. *Appl. Organomet. Chem.* **2008,** *22,* 300-307.
- Allis, D. G.; Spencer, J. T. "Nanostructural Architectures from Molecular Building Blocks" Handbook of Nanoscience, Engineering, and Technology, Second Edition (CRC Press), 2nd Edition, **2007**.
- Sinnot, S. B.; Spencer, J. T. (Eds.) *Journal of Nanoscience and Nanotechnology.* **2003,** *3,* 277-350.
- Allis, D. G.; Spencer, J. T. Nanostructural Architectures from Molecular Building Blocks. In *Handbook of Nanoscience, Engineering,* CRC Press, Lyshevski, S.E.; Brenner, D.; Iafrate, J.; Goddard, W. (Eds.) **2003,** 1601-1667.
- Taylor, J.; Englich, U.; Ruhlandt-Senge, K.; Spencer, J. T. Formation of New Nickel containing Nineteen-Vertex Metallaborane Clusters Prepared from the *Anti*-$B_{18}H_{22}$ Borane Cluster:

Molecular Structures of $[Ni(THF)_4(H_2O)_2][B_{18}H_{20}Ni(\eta^5\text{-}C_5H_5)]_2$ and $[B_{18}H_{19}(2\text{-}THF)Ni(\eta^5\text{-}C_5H_5)]$. *J. Chem. Soc., Dalton Trans.* **2002,** *17,* 3392-3397.

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Research Spotlight