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University of Guelph College of Physical and Engineering Science Chemistry Associate Professor Appointed: 2001

Mailing Address [\[edit\]](#)

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Qualifications [\[edit\]](#)

- M.Sc., Ludwig-Maximilians-Universität München, Chemistry, 1989.
- Ph.D., Technische Universität München, Chemistry, 1992.

Expertise and Research Interests [\[edit\]](#)

Intermediates of CVD Processes; Silicon and Germanium Chemistry; Carbenes and Carben-Analogs; Volatile Metal Complexes; Inorganic Photochemistry; Refractory Materials; Semiconductors; Thin Solid Films; Computational Chemistry; History of Chemistry; Solid State Physics; Temperature Routes to Metastable Phases; Low Valent Transition Metal Complexes; Multinuclear NMR (¹¹B, ¹⁵N, ¹⁷O, ²⁹Si and Transition Metals); Computational Chemistry (ab initio, DFT, Semi-Empirical, Molecular Modeling); Thioureas; Ionic Liquids; Carbenium Salts.

Future Research [\[edit\]](#)

We have obtained a new class of volatile metal complexes of copper, silver and gold. We have started with CVD experiments to optimize film growth, film purity etc.

Other Expertise [\[edit\]](#)

Consultant with CVDS, Galvanoform Inc. (Lahr, Germany), Mirotech. Inc. (Toronto), Dalton Chemicals (Toronto), Huys Inc. (Toronto), Bragg Photonics (Ottawa).

Industrial Relevance [\[edit\]](#)

Metallization, microelectronics, metal coatings, ceramic coatings, polymers, heavy metal removal, optoelectronics.

Keywords [\[edit\]](#)

COS Keywords:

Computational Chemistry, Electronic Materials, Photochemistry, Semiconductors, Solid State Physics.

Additional Terms:

Amido Complexes, Amines, Aromaticity, CVD, Computational Chemistry, Copper, Electronic Materials, Germanium, Gold, Inert Gas Techniques, NMR, Phosphorus, Planar Technology, Selenium, Silicon, Silver, Sulfur, Synthesis.

Languages [\[edit\]](#)

Reading, Writing, Speaking:

- Chinese, Mandarin: (basic, basic, basic)
- English: (fluent, fluent, fluent)
- French: (functional, functional, functional)
- German: (fluent, fluent, fluent)
- Russian: (basic, basic, basic)
- Spanish: (basic, basic, basic)

Memberships [\[edit\]](#)

- American Association for the Advancement of Science [Society Details](#)
- American Chemical Society
- Chemical Institute of Canada [Society Details](#)
- Gesellschaft Deutscher Chemiker

Honors and Awards [\[edit\]](#)

- 2000, Premiers Research Excellence Award, PREA Foundation, Ontario, Chemistry
- 1996-1998, Connaught Grant, Connaught Foundation, University of Toronto, Chemistry
- 1993-1994, Fedor Lynen Fellowship, Alexander von Humboldt Foundation, Chemistry

Previous Positions [\[edit\]](#)

- 1994-1995, Assistant Professor, Indiana University Purdue University Indianapolis, Faculty of Arts & Science, Chemistry
- 1993-1994, Research Associate, University of Wisconsin-Madison, College of Arts and Science, Chemistry
- 1992-1993, Research Director, Klinge Fujizawa, Klinge Holding & Research, Tibetan Ethnobotany
- 1989-1992, Lecture Assistant, Ph. D. Student, Technische Universitaet Muenchen, Chemistry, Inorganic
- 1982-1989, Student, Ludwig-Maximilians-Universitat Munchen, Chemistry
- 1980-1982, Surgical Assistant, Red Cross Hospital, Munich

Patents [\[edit\]](#)

- Polymeric Thioureas, Synthesis and Use, Patent Number: pending, 2000, Self-owned, United States of America. [Abstract](#) [USPTO Full-Text](#)
- Synthesis of Carbenes and Carbenium Cations from Aminals, Patent Number: pending, 2000, Self-owned, United States of America. [Abstract](#) [USPTO Full-Text](#)
- Amides of Divalent Carbon and Silicon, Patent Number: 5728856, 1998, Inventor: Denk, M. K., United States of America. [Abstract](#) [USPTO Full-Text](#)
- Synthesis of Stable Silylenes by Reduction Processes, Patent Number: DE 43 16 883 A1, 1994, Inventor: Denk, M. K., Germany.
- Cyclic Amides of Silicon and Germanium, Patent Number: DE 42 34 998 A1, 1994, Self-owned, Germany.
- Procedure for the Synthesis of Germaniumdichloride Ether Adducts, Patent Number: DE 42 14 281 A1, 1993, Inventors: Denk, M. K.; H, Germany.

Funding Received [\[edit\]](#)

- Natural Sciences and Engineering Research Council of Canada (NSERC): Amides of Divalent Silicon and Germanium as Precursors for Advanced Materials, \$63,000, Mar 11, 1996 to Mar 11, 1998.
- Connaught Fund (University of Toronto): New Ways for the Low-Temperature Deposition of Silicon, \$30,000, Mar 1996 to Mar 1997.
- Natural Sciences and Engineering Research Council of Canada (NSERC): Low Temperature Methods for the Deposition of Semiconductor Thin Films, \$64,000, Apr 1, 1998 to Apr 1, 2000.
- Equipment Grant: Dual Train Inert Gas Glove Box, 59,000, 2003 to .
- PREA Foundation (Ontario): Microelectronic Materials, \$150,000, 2002 to 2007.
- Amides in low coordination numbers: NSERC Operating Grant, \$44,000, 2000 to 2001.
- NSERC Major Installation Grant: 500 MHz NMR Instrument (with Prof. Peter Macdonald), \$850,000, 2000 to .
- NSERC, U of T: GC-MS instrument with full CI capability, \$104,000, 2000 to .
- IRAP - NRC (Ottawa): Hard Coating of Welding Tools, \$100,000, 1999 to 2000.
- NSERC (Operating Grant): Amides of Divalent Silicon and Germanium as Precursors for Advanced Materials, \$63,000, 1998 to 2000.
- Provosts Innovative Courseware Development Fund: The Virtual Laboratory III, \$9,600, 1998 to 1999.
- Provosts Innovative Courseware Development Fund: The Virtual Laboratory II, \$6,000, 1997 to 1998.
- Provosts Innovative Courseware Development Fund: The Virtual Laboratory I, \$12,000, 1996 to 1997.

Publications [\[edit\]](#)

- Michael K. Denk, Ken Hatano and Alan J. Lough, Synthesis and Characterization of a Carbene·SO₂ Adduct - New Insights into the Structure and Bonding of Thiourea S,S-Dioxides, *European Journal of Inorganic Chemistry*, 224-231, 2003
- Michael K. Denk, Nishi Gill, Gurmit Singh, Potential Explosion Hazard of α-Lithiated Amines, *Chemical And Engineering News*, 2-2, 2003
- Michael K. Denk, Mike J. Krause, Debyani G. Niyogi and Nachhattarpal K. Gill, Reaction of 1,2-Dibromoethane with Primary Amines: Formation of N,N'-Disubstituted Ethylenediamines RNH-CH₂CH₂-NHR and Homologous Polyamines RNH-[CH₂CH₂NR]_n-H, *Tetrahedron*, *accepted for publication*, 2003
- Yuehui Zhou and Michael K. Denk, Reaction Of Triethyl Orthoformate with Amines and Selenium - A convenient one-step three-component Synthesis for Selenoureas, *Tetrahedron Letters*, 44, 1295-1299, 2003
- Hitchcock, A. P., Ennis, L. E., Lehmann, J. F., Denk, M.K., Transient ISEELS: a new probe of chemical reactions, *Journal of El. Spec.*, *accepted for publication.*, 2001
- Michael K. Denk, Shilpi Gupta John Brownie Sabiha Tajammul, Alan J. Lough, C-H Activation with Elemental Sulfur: Synthesis of Cyclic Thioureas from Formaldehyde Aminals and S₈, *Chemistry, A European Journal*, 7, 4477-4486, 2001
- Denk, M. K., Rodezno, J., Gupta, S., Lough, A. J., Oxidation, Hydrogenation And Hydrolysis of Stable Diamino Carbenes, *Journal of Organometal. Chemistry*, *accepted for publication*, 2000
- Denk, M. K., Rodezno, J., Fast deuterium labeling and the basicity of stable diamino carbenes (imidazole-2-ylidenes), *Journal of Organometal. Chemistry*, *accepted for publication*, 2000
- Leites, L. A., Bukalov, S. S., Denk, M. K., West, R., Haaf M., Raman Evidence of Aromaticity of the Thermally Stable Silylene (tBuNCH=CHNtBu)Si, *Journal of Molecular Structure - THEOCHEM*, *in press*, 2000
- Lehmann, J. F., Urquhart, S. G., Ennis, L. E., Hitchcock, A. P., Hatano, K., Gupta, S., Denk, M. K., Core Excitation Spectroscopy of Stable Cyclic Diaminocarbenes, -Silylenes, and -Germylenes, *Organometallics*, 18, 1862-1872, 1999
- Denk, M. K., Hatano. K., Ma, M., Nucleophilic Carbenes and the Wanzlick Equilibrium A Reinvestigation, *Tetrahedron Letters*, 40, 2057-2060., 1999
- Denk, M. K., Gupta, S., Ramachandran, R., Aromatic Phosphenium Cations, *European Journal of Inorganic Chemistry*, 41-49, 1999
- Urquhart, S., Hitchcock, A. P., Denk, M. K., Probing Delocalization In Stable Silylenes: Core Excitation Spectra of Si(NRCH=CHNR), Si(NRCH₂-CH₂NR), H₂Si(NRCH=CHNR) and H₂Si(NRCH₂-CH₂NR), (R= tBu), *Organometallics*, 17, 2352 - 2360, 1998
- Denk, M. K., Hatano. K., Lough, A. J., Reactions Between Stable Carbene Analogues - Oxidation of a Stable Silylene by Tin(II)chloride, *European Journal of Inorganic Chemistry*, 1067 - 1070, 1998
- Haaf, M., Schmiedl, A., Schmedake, T. A., Powell, R. A., Millevolte, A. J., Denk, M. West, R. “, Synthesis and Reactivity of a Stable Silylene, *Journal of the American Chemical Society*, 120, 12714-12719, 1998
- Denk, M. K., Khan, M., Lough, A. J., Shuchi, K., Redetermination of the Germanium Dichloride complex with 1,4 Dioxane at 173K, *Acta Crystallographica*, C54, 1830-1831, 1998
- Denk, M. K., Thadani, A., Hatano, K., Lough, A. J., The Steric Stabilization of Nucleophilic Carbenes, *Angewandte Chemie, International Edition in English*, 36, 2607-2609, 1997
- West, R., Denk, M., Stable Silylenes: Synthesis, Structure, Reactions, *Pure and Applied Chemistry*, 68, 785 - 788, 1996
- Metzler, N., Denk, M. K., Synthesis of a Silylene Borane Adduct and its slow conversion into a Silylborane, *Journal of the Chemical Society, Chemical Communications*, 2657 - 2658, 1996
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9028, 1996

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- Denk, M., Hayashi, R. K., West, R., Reaction of a Stable Silylene with Covalent Azides: A new Synthesis for Silaimines, *Journal of the American Chemical Society*, 116, 10813 - 10814, 1994
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- Denk, M., Hayashi, R. K., West, R., Silylene Complexes from a Stable Silylene and Metal Carbonyls: Synthesis and Structure of (LSi:)2Ni(CO)2, a Donor-free Bis-silylene Complex, *Journal of the Chemical Society, Chemical Communications*, 33 - 34, 1994
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Last Updated: 10/14/2006

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