Faculty Profile

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Dominic McGrath

Professor

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Honors

- Camille Dreyfus Teacher Scholar Award, 1999-2004
- Research Corporation Cottrell Scholar, 1997-2002
- NSF CAREER Award, 1997-2002

Education and Appointments

- B.S. 1986, Yale University
- Ph.D. 1992, California Institute of Technology
- Postdoctoral 1992-1994, The Scripps Research Institute
- Postdoctoral 1994, California Institute of Technology

Research Interests

- Organic
- Energy Science
- Materials and Polymer Chemistry
- Synthesis/Synthetic Methods Development

Research Summary

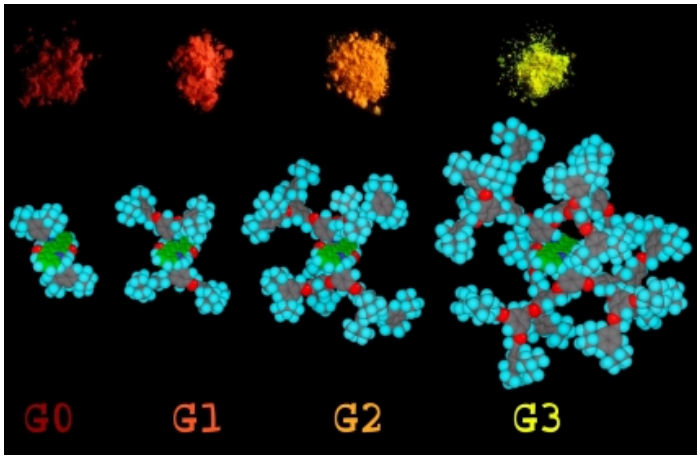
Organic, Organometallic, and Polymer Chemistry/Materials for Energy Conversion

Our research program involves the use of organic synthesis for the design, development, and application of new concepts in macromolecular, supramolecular, and materials chemistry. Our research efforts span a number of areas in the chemical sciences and include studies of (a) materials for solar energy conversion, (b) macromolecular systems that undergo structural changes in response to visible light and other stimuli, and (c) the influence of dendritic components of nanoscopic systems on phonic and electronic properties of materials.

We have developed several new classes of dendritic materials containing photochromic subunits. As nature uses light energy to alter function in photoresponsive systems such as photosynthesis, vision, phototropism, and phototaxis, we use light energy to drive gross topological or constitutional changes in fundamentally new dendritic architectures with precisely placed photoresponsive subunits. In short, we can drive dendrimer properties with light stimuli. We have developed two entirely new classes of photoresponsive dendritic macromolecules: (1) Photochromic Dendrimers, and (2) Photolabile Dendrimers. We anticipate that switchable and degradable dendrimers of this type will have application in small molecule transport systems based on their ability to reversibly encapsulate guest molecules. We are continuing to develop these materials as potential transport hosts and photoresponsive supramolecular assemblies.

Our interest in labile macromolecular structures has led to our development of the process of dendrimer disassembly, whereby a triggering stimulus initiates an electronic cascade cleavage of

dendritic structures into individual dendrimer subunits or larger dendrimer fragments. This chemistry introduces a new paradigm for the use of dendritic structures based on (1) the nature of dendrimers as covalent assemblages of active species, and using the chemistry of disassembly to release these species into a system; and (2) the role of dendritic components of a system in influencing solubility, energy harvesting, or insulating capabilities, etc., and using the chemistry of disassembly to reverse those contributions to a system. This is a powerful construct, in that dendrimers and dendritic structures can be made up of a wide variety of subunits, compatibilized with many different environments, and incorporated into countless systems. We anticipate that dendritic materials with disassembly capabilities will (a) be useful for traditional polymer degradation technologies, and (b) have potential applications in nanotechnology, biomedicine, sensors, etc.



Reduced aggregation of a quinacridone core in dendrimers of increasing generation enhances solid state luminescence efficiency [Chem. Commun. 2005 444]

Selected Publications

- "Electron Transfer Processes in Zinc Phthalocyanine-Phosphonic Acid Monolayers on ITO: Characterization of Orientation and Charge Transfer Kinetics By Waveguide Spectroelectrochemistry," Lin, H.-C.; Polaske, N.W.; Oquendo, L.E.; Gliboff, M.; Knesting, K.M.; Nordlund, D.; Ginger, D.S.; Ratcliff, E.L.; Beam, B.M.; Armstrong, N.R.; McGrath, D.V.; Saavedra, S.S. *J. Phys. Chem. Lett.* 2012, *3*, 1154-1158.
- "Vanillin and o-vanillin oligomers as models for dendrimer disassembly," Kevwitch, R.M.; Shanahan, C.S.; McGrath, D.V. *New J. Chem.* 2012, *36*, 492-505.
- "Phosphonic Acid Functionalized Asymmetric Phthalocyanines: Synthesis, Modification of Indium Tin Oxide (ITO), and Charge Transfer," Polaske, N.W.; Lin, H.-C.; Tang, A.; Mayukh, M.; Oquendo, L.E.; Green, J.T.; Ratcliff, E.R.; Armstrong, N.R.; Saavedra, S.S.; McGrath, D.V. *Langmuir* 2011, *25*, 14900-14909.
- "Thermally Reversible Dendronized AB Step-Polymers via "Click" Chemistry," Polaske, N.W.; McGrath, D.V.; McElhanon, J.R. *Macromolecules* 2011, *44*, 3203-3210.
- "Peripheral Substitution of a Near-IR Absorbing Soluble Phthalocyanine Using 'Click' Chemistry," Mayukh, M.; Lu, C.-W.; Hernandez, E.; McGrath, D.V. *Chem. Eur. J.* 2011, *17*, 8472-8478.
- "Solvent-Free Synthesis of Soluble, Near-IR Absorbing Titanyl Phthalocyanine Derivatives," Mayukh, M.; Sema, C.M.; Roberts, J.M.; McGrath, D.V. *J. Org. Chem.* 2010, *75*, 7893-7896.
- "Convergent Synthesis of Geometrically Disassembling Dendrimers using Cu(I)-Catalyzed C-O Bond Formation," Polaske, N.W.; Szalai, M.L.; Shanahan, C.S.; McGrath, D.V. *Org. Lett.* 2010, *12*, 4944-4947.
- "Polymeric Endoaortic Paving (PEAP): Thermomechanical and Degradation Properties of Polycaprolactone/Polyurethane Blends for Cardiovascular Applications," Ashton, J.H.; Mertz, J.A.; Harper, J.L.; Slepian, M.J.; Mills, J.L.; McGrath, D.V.; Vande Geest, J.P. *Acta Biomaterialia* 2010, *7*, 287-294.
- "Improved Iterative Synthesis of Linearly Disassembling Dendrons," Ortiz, A.; Shanahan, C.S.; Sisk, D.T.; Perera, S.C.; Rao, P.; McGrath, D.V. *J. Org. Chem.* 2010, *75*, 6154-6162.
- "Frustration of Condensed Phase Aggregation of Naphthalocyanine by Dendritic Site-Isolation," Chen, X.; Fernando, N.; McGrath, D.V. *Macromolecules* 2010, *43*, 5512-5514.
- "Effect of Crosslinker Length and Composition on the Hydrophobicity and Thermomechanical

Response of Acrylate-based Shape Memory Polymers," Warren P.D.; McGrath D.V.; Vande Geest J.P.? *Macromolecular Materials and Engineering* 2010, *295*, 386-396.?

- "Thermally Reversible Dendronized Step-Polymers Based on Sequential Huisgen 1,3-Dipolar Cycloaddition and Diels-Alder "Click" Reactions," Polaske, N.W.; McGrath, D.V.; McElhanon, J.R. *Macromolecules* 2010, *43*, 1270-1276.
- "Modification of Symmetrically Substituted Phthalocyanines Using Click Chemistry: Phthalocyanine Nanostructures by Nanoimprint Lithography," Chen, X.; Thomas, J.; Gangopadhyay, P; Norwood R.A.; Peyghambarian, N.; McGrath, D.V. *J. Am. Chem. Soc.* 2009, *131*, 13840-13843.
- "Synthesis of Chiral Amine-Imine Ligands and Their Application in Palladium-Catalyzed Allylic Alkylation," Chen, H.; Sweet, J.A.; Lam, K.-C.; Rheingold, A.L.; McGrath, D.V. *Tetrahedron: Asymmetry* 2009, *20*, 1672-1682.
- "Synthesis and Study of Non-Aggregating Octasubstituted Dendritic Phthalocyanines, " Kernag, C.A; McGrath, D.V. *Israel J. Chem.* 2009 *49*, 9-21.
- "Asymmetric Phthalocyanine Synthesis by ROMP-Capture-Release." Chen, X.; Salmon III, T. R.; McGrath, D. V. *Org. Lett.* 2009 *11*, 2061-2064.
- "Site-isolated, Intermolecularly Photocrosslinkable and Patternable Dendritic Quinacridones," D'Ambruoso, G.D.; Ross, E.E.; Armstrong, N.R.; McGrath, D.V. *Chem. Commun.* 2009 3222-3224.
- "Synthesis and Degradation of Photolabile Dendrimers Based on o-Nitrobenzyl Ether Photolabile Cores," Kevwitch, R.M.; McGrath, D.V. *New J. Chem* 2007 *31*, 1332-1336.
- "EAP hydrogels for pulse-actuated cell system (PACS) architectures." Plata, R. Erik; Rogers, Hallena R.; Banister, Mark; Vohnout, Sonia; McGrath, Dominic V. Proc. *SPIE* 2007 *6524* (Electroactive Polymer Actuators and Devices (EAPAD) 2007), 65241T/1-65241T/8.
- "Dendrimers Based on Thermally Reversible Furan-Maleimide Diels-Alder Adducts," Szalai, M. L.; McGrath, D.V.; Wheeler, D.R.; Zifer, T.; McElhanon, J.R. *Macromolecules* 2007 *40*, 818-823.
- "Synthesis and Degradation of Photolabile Dendrimers Based on o-Nitrobenzyl Ether Photolabile Cores," Kevwitch, R.M.; McGrath, D.V. *New J. Chem* 2007 *31*, 1332-1336.
- "Langmuir and Grafted Monolayers of Photochromic Amphiphilic Monodendrons of Low Generations," Genson, Kirsten L.; Holzmuller, Jason; Villacencio, Ovette F.; McGrath, Dominic V.; Vaknin, David; Tsukruk, Vladimir V. *J. Phys. Chem. B* 2005 *109*, 20393-20402.
- "Dendrimer Disassembly as a New Paradigm for the Application of Dendritic Structures," McGrath, D.V. *Molecular Pharmaceutics* 2005 *2*, 253-263.
- "Dendritic incorporation of quinacridone: solubility, electrochemistry, and solid state luminescence," Ortiz, A.; Flora, W.H.; D'Ambruoso, G.D.; Armstrong, N.R.; McGrath, D.V. *Chem. Commun.* 2005 444-446.
- "Phototriggering of geometric dendrimer disassembly: an improved synthesis of 2,4-bis (hydroxymethyl)phenol based dendrimers," Szalai, M.L.; McGrath, D.V. *Tetrahedron* 2004 *60*, 7261-7266.
- "Photoswitchable Flexible and Shape-Persistent Dendrimers. Comparison of the Interplay between a Photochromic Azobenzene Core and Dendrimer Structure," Liao, L.-X.; Stellacci, F.; McGrath, D.V. *J. Am. Chem. Soc.* 2004 *126*, 2181-2185.
- "Geometric Disassembly of Dendrimers: Dendritic Amplification," Szalai, M.L.; Kevwitch, R.M.; McGrath, D.V. *J. Am. Chem. Soc.* 2003 *125*, 15688-15689.
- "Dendrimer Disassembly by Benzyl Ether Depolymerization," Li, S.; Szalai, M.L.; Kevwitch, R.M.; McGrath, D.V. *J. Am. Chem. Soc.* 2003 *125*, 10516-10517.
- "Non-aggregating octasubstituted dendritic phthalocyanines," Kernag, C.A.; McGrath, D.V. *Chem. Commum.* 2003 1048-1049.
- "Azobenzene-Containing Dendrimers." Villavicencio, O.F.; McGrath, D.V. *Advances in Dendritic Macromolecules* 2002 *5*, 1-44.
- "Synthesis of Photolabile Dendrimer Cores," Kevwitch, R.M.; McGrath, D.V. *Synthesis* 2002 1171-1176.
- "Hydrobenzoin-Based Rigid Chiral Polymer." Bieging, A.R.; Liao, L.-X.; McGrath, D.V. *Chirality* 2002 *14*, 258-263.
- "Photochromic Dendrimers Containing Six Azobenzenes." Liao, L.-X.; Junge, D.M.; McGrath, D. V. *Macromolecules*. 2002 *35*, 319-322.

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