

Jörg G. Werner, Ph.D.

Assistant Professor
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Scholarly Profile

My research group is interested in the interplay of functional materials and structures with features sizes from the nano- to the microscale, with focus on spatially controlled and nanoconfined synthesis of functional materials. The intrinsic properties of many soft and hard functional materials can gain enhanced functionality when fabricated in simple to complex architectures. We have experience in the synthesis, characterization, and application of soft polymeric, as well as hard, solid-state and crystalline materials with well-defined structures, including three-dimensionally periodic nanonetworks from block copolymer self-assembly for energy storage and dynamically responsive micro-architectures from complex fluids.

Current Position

Assistant Professor at Boston University

2020-present

- Polymeric and complex fluidic self-assembly and structure formation for bottom-up synthesis of functional nano- to micro-structures.
- Three-dimensionally integrated solid-state energy storage devices.
- Surface confined synthesis and coating of complex nano- and micro-architectures.

Research Experience prior to BU

Post-Doctoral Research at Harvard University with David Weitz

2016-2019

- Microfluidic emulsion templating for the fabrication of reversibly stimuli responsive polymeric membranes as dynamic microcapsules for controlled capture and release (*Adv. Funct. Mater.* 2018 and *Macromolecules* 2018).

PhD in Chemistry at Cornell University with Ulrich Wiesner

2011-2015

- Developed a three-dimensionally integrated nanohybrid for energy storage, featuring an ordered 3-D networked (gyroidal) mesoporous carbon anode, coated with an ultra-thin polymer electrolyte, and backfilled with a sulfur-polymer cathode composite. Each component with dimensions of less than 20 nm was integrated in a monolithic solid-state 3-D architecture that exhibited battery-like characteristics.
- Developed highly stable gyroidal mesoporous carbon with the largest reported pore size of 39 nm for soft-templated ordered mesoporous carbons, the first reported single gyroidal mesoporous carbon network, with thermal stability up to 1600 °C and ultra-large surface area of over 2000 m² g⁻¹ (*ACS Nano* 2014). The gyroidal carbon materials were used as functional sulfur host in lithium-sulfur batteries and nanoporous 3-D substrates for ALD (*Nanoscale* 2014 and *Chemistry of Materials* 2015).
- Synthesized and characterized hierarchically macro- and mesoporous carbon structures with graded macroporosity using polymeric hard-templates, as well as their first one-pot soft-templating route (published in *Nanoscale* 2015 and *ACS Macro Letters* 2015).

Peer-Reviewed Publications

Selected

1. **J. G. Werner**, G. G. Rodríguez-Calero, H. D. Abruña, U. Wiesner, “Block copolymer derived 3-D interpenetrating multifunctional gyroidal nanohybrids for electrical energy storage” *Energy Environ. Sci.* **11**, 1261-1270 (2018).
2. **J. G. Werner**, B. T. Deveney, S. Nawar, D. A. Weitz, “Dynamic Microcapsules with Rapid and Reversible Permeability Switching” *Adv. Funct. Mater.* 1803385 (2018).
3. **J. G. Werner***, S. Nawar*, A. A. Solovev, D. A. Weitz, “Hydrogel Microcapsules with Dynamic pH-Responsive Properties from Methacrylic Anhydride” *Macromolecules* **51**, 5798–5805 (2018). (*Contributed equally)
4. **J. G. Werner**, S. S. Johnson, V. Vijay, U. Wiesner, “Carbon-Sulfur Composites from Cylindrical and Gyroidal Mesoporous Carbons with Tunable Properties in Lithium-Sulfur Batteries”, *Chem. Mater.* **27**, 3349-3357 (2015).
5. S. A. Hesse,* **J. G. Werner,*** U. Wiesner, “One-pot Synthesis of Hierarchically Macro and Mesoporous Carbon Materials with Graded Porosity”, *Macroletters* **4**, 477-482 (2015). (*Contributed equally)
6. **J. G. Werner**, T. N. Hoheisel, U. Wiesner, “Synthesis and Characterization of Gyroidal Mesoporous Carbons and Carbon Monoliths with Tunable Ultralarge Pore Size”, *ACS Nano* **8** (1), 731-743 (2014).
7. **J. G. Werner**, M. Scherer, U. Steiner, U. Wiesner, “Gyroidal Mesoporous Multifunctional Nanocomposites via Atomic Layer Deposition”, *Nanoscale* **6**, 8736-8742 (2014).

Others

8. J. Liu, H. Chen, X. Shi, S. Nawar, **J. G. Werner**, G. Huang, M. Ye, D. A. Weitz, A. A. Solovev, Y. Mei, “Hydrogel Microcapsules with Photocatalytic Nanoparticles for Removal of Organic Pollutants” *Environ. Sci.: Nano* (2020) DOI: 10.1039/C9EN01108K
9. K. W. Tan, **J. G. Werner**, M. Goodman, H. Seong Kim, B. Jung, H. Sai, P. V. Braun, M. O. Thompson, U. Wiesner, „Synthesis and Formation Mechanism of All-Organic Block Copolymer-Directed Templating of Laser-Induced Crystalline Silicon Nanostructures” *ACS Appl. Mater. Interfaces* (2018), DOI: 10.1021/acsami.8b12706
10. D. Bolmatov, Q. Zhang, D. Soloviov, Y. Mun Li, **J. G. Werner**, A. Suvorov, Y. Q. Cai, U. B. Wiesner, M. Zhernenkov, J. Katsaras, “Nanoscale Q-resolved phonon dynamics in block copolymers” *ACS Appl. Nano Mater.*, **1**, 4918–4926 (2018).
11. Q. Zhang, F. Matsuoka, H. S. Suh, P. A. Beaucage, S. Xiong, D.-M. Smilgies, K. W. Tan, **J. G. Werner**, P. F. Nealey, U. Wiesner, "Pathways to mesoporous resin/carbon thin films with alternating gyroid morphology" *ACS Nano* **12**, 347-358 (2018).
12. D. V. Amato, H. Lee, **J. G. Werner**, D. A. Weitz, D. L. Patton, “Functional Microcapsules via Thiol- Ene Photopolymerization in Droplet-Based Microfluidics” *ACS Applied Materials & Interfaces* **9**, 3288–3293 (2017).
13. B. D. A. Levin. J. J. Zachman, **J. G. Werner**, R. Sahore, K. X, *et al.* "Characterization of Sulfur and Nanostructured Sulfur Battery Cathodes in Electron Microscopy Without Sublimation Artifacts" *Microsc. Microanal.* **23**, 155-162 (2017).

14. S. W. Robbins, P. A. Beaucage, H. Sai, K. Wee Tan, **J. G. Werner**, J. P. Sethna, F. J. DiSalvo, S. M. Gruner, R. B. van Dover, U. Wiesner, "Block Copolymer Self-Assembly Directed Synthesis of Mesoporous Gyroidal Superconductors", *Sci. Adv.* **2**, 1501119 (2016).
15. K. W. Tan, B. Jung, **J. G. Werner**, E. R. Rhoades, M. O. Thompson, U. Wiesner, "Transient Laser Heating Induced Hierarchical Porous Structures from Block Copolymer-directed Self-assembly", *Science* **349**, 54-58 (2015).
16. K. W. Tan, H. Sai, S. W. Robbins, **J. G. Werner**, T. N. Hoheisel, S. A. Hesse, P. Beaucage, F. J. DiSalvo, S. M. Gruner, M. Murtagh, and U. Wiesner, "Ordered mesoporous crystalline aluminas from self-assembly of ABC triblock terpolymer-butanol-alumina sols", *RSC Adv.* **5**, 49287-49294 (2015).
17. Y. Gu, **J. G. Werner**, R. M. Dorin, S. W. Robbins, U. Wiesner, "Graded Porous Inorganic Materials Derived from Self-Assembled Block Copolymer Templates", *Nanoscale* **7**, 5826-5834 (2015).
18. R. M. Dorin, W. A. Phillip, H. Sai, **J. G. Werner**, M. Elimelech, U. Wiesner, "Designing Block Copolymer Architectures for Targeted Membrane Performance", *Polymer* **55** 347-353 (2014).
19. S. C. Warren, M. R. Perkins, A. M. Adams, M. Kamperman, A. A. Burns, H. Arora, E. Herz, T. Suteewong, H. Sai, Z. Lui, **J. G. Werner**, *et al.*, "A Silica Sol-Gel Design Strategy for Nanostructured Metallic Materials", *Nature Mater.* **11**, 460-467 (2012).
20. W. A. Philipp, R. M. Dorin, **J. G. Werner**, E. M. V. Hoek, U. Wiesner, M. Elimelech, "Tuning Structure and Properties of Graded Triblock Terpolymer-Based Mesoporous Hybrid Films", *Nano Lett.* **11**, 2892-2900 (2011).

Patents

1. U. B. Wiesner, **J. G. Werner**, G. G. Rodriguez-Calero, H. D. Abruna, "Solid-State Three-Dimensional Battery Assembly", US Patent No.: 10,103,408
2. U. B. Wiesner, **J. G. Werner**, "Gyroidal Mesoporous Carbon Materials and Methods Thereof" US Patent No.: 9,714,173
3. U. B. Wiesner, R. M. Dorin, **J. G. Werner**, W. A. Phillip; "Multiblock Copolymer Films, Methods of Making Same, and Uses Thereof" US Patent No.: 9,527,041
4. D. A. Weitz, **J. G. Werner**, S. Nawar, B. T. Deveney; „Poly(acid) Microcapsules And Related Methods”, US Application No.: 62/547,904

Awards and Fellowships

Howard Neal Wachter Memorial Prize	2014
Department of Chemistry, Cornell University.	
Best Student Poster Award	2013
CFES 2012-2013 Annual Conference in Troy, NY.	
Young Investigator Award	2012
Energy Materials Center Cornell (emc ²).	
Research scholarship of the Graduate School of Excellence MAINZ	2009-2010
Polymers in Advanced Materials (POLYMAT).	

Conferences and Seminars

Invited Talks and Lectures

1. Society of Plastics seminar at the University of Connecticut, Storrs CT, September **2018**: *Dynamically Responsive Microcapsules from Microfluidic Complex Emulsion Drop Templating*.
2. Soft Materials, Structures and Devices (SMSD) seminar at Massachusetts Institute of Technology, Cambridge MA, March **2018**: *From Block Copolymer Self-Assembly to 3-D Nano-integrated Energy Storage Devices*.
3. Special Seminar at UMass Amherst, Amherst MA, March **2017**: *From Block Copolymer Self-Assembly to 3D Ordered Functional Nanohybrids*.
4. Guest Lecture at UMass Amherst (CHEM-ENG 590E, course by Sarah Perry), Mar. **2017**: *Droplet Microfluidics*.
5. Squishy Physics Seminar at Harvard University, Cambridge MA, Feb. **2016**: *From Block Copolymer Self-Assembly to 3D Ordered Functional Nanohybrids*.
6. Chemistry Grad and Postdoc Seminar at Cornell University, Ithaca NY, Mar. **2015**: *Gyroidal Mesoporous Carbon Materials: Tunable Synthesis, Modifications, and Application*.

Selected Conference Talks

J. G. Werner, S. Nawar, Z. Wu, B. Deveney, H. Lee, D. Weitz, *Dynamic microcapsules with reversibly trigger-responsive membranes*, ACS Fall meeting in Boston MA, Aug. **2018**.

J. G. Werner, H. Lee, U. Wiesner, D. Weitz, *Block copolymer self-assembly in microfluidically produced double emulsion droplets*, ACS Fall meeting in Boston MA, Aug. **2018**.

J. G. Werner, G. G. Rodríguez-Calero, H. D. Abruña, U. Wiesner, *From Block Copolymer Self-Assembly to 3-D Nano-integrated Energy Storage Devices*, ACS Fall meeting in Boston MA, Aug. **2018**.

J. G. Werner, H. Lee, U. Wiesner, D. Weitz, *Microcapsules with Ordered Nanoporous Shells from Block Copolymer Self-Assembly in Double Emulsion Drops*, MRS Fall meeting in Boston MA, Dec. **2017**.

J. G. Werner, G. G. Rodríguez-Calero, H. D. Abruña, U. Wiesner, *Nano-Integrated Ordered Three-Dimensional Multifunctional Hybrid for All-Solid-State Energy Storage*, ACS Fall meeting in Washington DC, Aug. **2017**.

J. G. Werner, B. Deveney, S. Nawar, H. Lee, D. Weitz, *Dynamically Responsive Hydrogel Microcapsules*, ACS Fall meeting in Washington DC, Aug. **2017**.

J. G. Werner, Gabriel G. Rodríguez-Caléro, Héctor. D. Abruña, U. Wiesner, *Block Copolymer Based Integrated Three-Dimensional Multifunctional Nanohybrid for All-Solid-State Energy Storage*, MRS 2015 Fall meeting in Boston MA, Dec. **2015**.

J. G. Werner, S. S. Johnson, M. R. J. Scherer, U. Steiner, U. Wiesner, *Gyroidal Mesoporous Multifunctional Core-Shell Nanocomposites*, MRS 2014 Fall meeting in Boston MA, Dec. **2014**.

J. G. Werner, T. H. Hoheisel, U. Wiesner, *Systematic Study on Carbon-Sulfur Composites Using Cylindrical and Co-Continuous Ordered Mesoporous Carbons with Tunable Porosity*, MRS 2013 Fall meeting in Boston MA, Dec. **2013**.

J. G. Werner, U. Wiesner, *Block Copolymer-Based Nanomaterials for Energy Conversion and Storage*, CFES 2012-2013 Annual Conference in Troy NY, Jan. **2013**.

Professional Activities, Development, and Outreach

- Member of the American Chemical Society (ACS), Materials Research Society (MRS), and the American Institute of Chemical Engineers (AIChE).
- Organizer of the weekly seminar series "Squishy Physics" in the School of Engineering and Applied Sciences at Harvard University (2016-present).
- Reviewer for *Nature Communications*, *Colloid and Polymer Science*, *Applied Nanoscience*.
- Certified Participation in "*Building Mentoring Skills for an Academic Career Certificate Program*", 6 sessions mentoring seminar series (2015).
- Participation in the safety workshop "*Chemical Reactivity Hazards: Laboratory-scale Recognition and Control*" by Principal Midwest Chemical Safety, LLC (2014).
- Session Chair at the American Chemical Society Fall meeting 2017 in Washington, DC.
- Student organizer of the "*Lithium-Sulfur Battery Initiative*" in the Energy Materials Center at Cornell (2012-2014).
- Chemistry lab and safety monitor in the Weitz group, Harvard University (2016-present).
- Group Safety Officer of the Wiesner group, Cornell University (2013 - 2015).
- Mentored more than a dozen undergraduate and graduate students in laboratory research work by teaching safe chemical lab practice, providing appropriate research projects, discussing and evaluating results, and advising on scientific writing and presenting.
- Supervised a group of undergraduate students for a "senior lab" class by designing a one-semester research project, teaching safe chemical lab practice, providing guidance for experimental work, scientific writing, and preparation of scientific presentations (2015).
- Volunteer at outreach programs such as *NanoDays* (2014, 2017) and *Expanding your Horizons* (EYH 2012-2015), a one-day conference for 7th–9th grade girls, to stimulate the participants' interest in math and science through hands-on activities at an early age.