

Curriculum Vitae – David M. Walba

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PRESENT POSITIONS

1988-present Professor
 DEPARTMENT OF CHEMISTRY, UNIVERSITY OF COLORADO BOULDER

PREVIOUS POSITIONS

2006-2009 Chair
 DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY
UNIVERSITY OF COLORADO BOULDER
1983-1987 Associate Professor
 DEPARTMENT OF CHEMISTRY, UNIVERSITY OF COLORADO BOULDER
1977-1983 Assistant Professor
 DEPARTMENT OF CHEMISTRY, UNIVERSITY OF COLORADO BOULDER

EDUCATION UNIVERSITY OF CALIFORNIA, BERKELEY

BS (Phi Beta Kappa) in Chemistry (1971)

CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA
Ph.D. in Chemistry (1975) with Robert E. Ireland

UNIVERSITY OF CALIFORNIA, LOS ANGELES
Postdoctoral Fellow (1975-1977) with Donald J. Cram

HONORS College Scholar Award, CU College of Arts and Sciences (2012)

AAAS Fellow (1999)
Chair of the 1999 Gordon Research Conference on Liquid Crystals
University of Colorado Faculty Fellowships (1995, 1988, 1984)
Camille and Henry Dreyfus Teacher Scholar (1984-1986)
A.P. Sloan Foundation Fellowship (1982-1984)
NIH Postdoctoral Fellowship (1976)
NDEA Graduate Fellowship (1971-1974)

OTHER PROFESSIONAL EXPERIENCE

1994-2001 Director
 DISPLAYTECH, INC., LONGMONT, COLORADO
1984-1994 Co-Founder and Vice President for Chemical Research
 DISPLAYTECH, INC., BOULDER, COLORADO

Thirty-nine Ph.D. degrees and twelve master's degrees have been awarded in areas ranging from natural products total synthesis to topological stereochemistry to liquid crystals and soft condensed matter. Current research focuses on supramolecular stereochemistry, chirality and polarity in smectic liquid crystals, and new materials for organic electronics. Currently, the research group consists of a senior postdoc and four graduate students.

Selected Recent Publications (Career Total: 361)

Refereed Journal Articles and Refereed Conference Proceedings (Career total: 208)[1]

1. Chen, X., E. Korblova, M. A. Glaser, J. E. MacLennan, D. M. Walba, and N. A. Clark. "Polar in-Plane Surface Orientation of a Ferroelectric Nematic Liquid Crystal: Polar Monodomains and Twisted State Electro-Optics." *Proceedings of the National Academy of Sciences of the United States of America* 118, no. 22 (Jun 2021): e2104092118. <https://doi.org/10.1073/pnas.2104092118>. <Go to ISI>://WOS:000659461200011.
2. Chen, X., E. Korblova, D. P. Dong, X. Y. Wei, R. F. Shao, L. Radzihovsky, M. A. Glaser, *et al.* "First-Principles Experimental Demonstration of Ferroelectricity in a Thermotropic Nematic Liquid Crystal: Polar Domains and Striking Electro-Optics." DMW refereed paper. *Proceedings of the National Academy of Sciences of the United States of America* 117, no. 25 (Jun 2020): 14021-31. <https://doi.org/10.1073/pnas.2002290117>. <Go to ISI>://WOS:000546772500001.
3. You, R.; Park, W.; Carlson, E.; Ryu, S. H.; Shin, M. J.; Guzman, E.; Ahn, H.; Shin, T. J.; Walba, D. M.; Clark, N. A.; Yoon, D. K. "Nanoconfined heliconical structure of twist-bend nematic liquid crystal phase," *Liquid Crystals* **2019**, *46*, (2), 316-325. **DOI: 10.1080/02678292.2018.1508770**
4. Tuchband, M. R.; Paterson, D. A.; Salamonczyk, M.; Norman, V. A.; Scarbrough, A. N.; Forsyth, E.; Garcia, E.; Wang, C.; Storey, J. M. D.; Walba, D. M.; Sprunt, S.; Jakli, A.; Zhu, C.; Imrie, C. T.; Clark, N. A. "Distinct differences in the nanoscale behaviors of the twist-bend liquid crystal phase of a flexible linear trimer and homologous dimer," *Proc Natl Acad Sci U S A* **2019**, *116*, (22), 10698-10704. **DOI: 10.1073/pnas.1821372116**
5. Green, A. A. S.; Tuchband, M. R.; Shao, R. F.; Shen, Y. Q.; Visvanathan, R.; Duncan, A. E.; Lehmann, A.; Tschierske, C.; Carlson, E. D.; Guzman, E.; Kolber, M.; Walba, D. M.; Park, C. S.; Glaser, M. A.; MacLennan, J. E.; Clark, N. A. "Chiral incommensurate helical phase in a smectic of achiral bent-core mesogens," *Physical Review Letters* **2019**, *122*, (10). **DOI: 10.1103/PhysRevLett.122.107801**
6. Foley, L.; Park, W.; Yang, M.; Carlson, E.; Korblova, E.; Yoon, D. K.; Walba, D. M. "Nanoconfinement of the low-temperature dark conglomerate: Structural control from focal conics to helical nanofilaments," *Chemistry* **2019**, *25*, (31), 7438-7442. **DOI: 10.1002/chem.201900653**
7. Theis, J. G.; Smith, G. P.; Yi, Y.; Walba, D. M.; Clark, N. A. "Liquid crystal phase behavior of a DNA dodecamer and the chromonic dye sunset yellow," *Phys. Rev. E* **2018**, *98*, (4). **DOI: 10.1103/PhysRevE.98.042701**
8. Moran, M. J.; Magrini, M.; Walba, D. M.; Aprahamian, I. "Driving a liquid crystal phase transition using a photochromic hydrazone," *J. Am. Chem. Soc.* **2018**, *140*, (42), 13623-13627. **DOI: 10.1021/jacs.8b09622**
9. Han, M. J.; Wei, D.; Kim, Y. H.; Ahn, H.; Shin, T. J.; Clark, N. A.; Walba, D. M.; Yoon, D. K. "Highly oriented liquid crystal semiconductor for organic field-effect transistors," *ACS Central Science* **2018**. **DOI: 10.1021/acscentsci.8b00465**
10. Shi, Y.; Sun, Z.; Chen, R.; Zhu, C.; Shoemaker, R. K.; Tsai, E.; Walba, D. M.; Glaser, M. A.; MacLennan, J. E.; Chen, D.; Clark, N. A. "Effect of conformational chirality on optical activity observed in an achiral, bent-core molecule," *J Phys Chem B* **2017**. **DOI: 10.1021/acs.jpcc.7b04033**
11. Scarbrough, A. N.; Tuchband, M. R.; Korblova, E. D.; Shao, R.; Shen, Y.; MacLennan, J. E.; Glaser, M. A.; Clark, N. A.; Walba, D. M. "The heliconical nematic twist-bend phase from "classic" bent-core benzylideneanilines with oligomethylene cores," *Mol. Cryst. Liquid Cryst.* **2017**, *647*, (1), 430-438. **DOI: 10.1080/15421406.2017.1290396**
12. Korblova, E. D.; Guzman, E.; MacLennan, J. E.; Glaser, M. A.; Shao, R. F.; Garcia, E.; Shen, Y. Q.; Visvanathan, R.; Clark, N. A.; Walba, D. M. "New smap(f) mesogens designed for analog electrooptics applications," *Materials* **2017**, *10*, (11). **DOI: 10.3390/ma10111284**
13. Kim, H.; Ryu, S. H.; Tuchband, M.; Shin, T. J.; Korblova, E.; Walba, D. M.; Clark, N. A.; Yoon, D. K. "Structural transitions and guest/host complexing of liquid crystal helical nanofilaments induced by nanoconfinement,"

Science Advances **2017**, 3, (2). DOI: 10.1126/sciadv.1602102

14. Khoo, I. C.; Korblova, E. D.; Carlson, E.; Tuchband, M. R.; Walba, D. M.; Clark, N. A.; Yoon, D. K.; Gim, M.-J.; Ryu, S.; Visvanathan, R.; Guzman, E.; Foley, L. M., Homeotropic alignment of multiple bent-core liquid crystal phases using a polydimethylsiloxane alignment layer. In *Liquid Crystals XXI*, 2017.
15. Zhu, C.; Tuchband, M. R.; Young, A.; Shuai, M.; Scarbrough, A.; Walba, D. M.; MacLennan, J. E.; Wang, C.; Hexemer, A.; Clark, N. A. "Resonant carbon k-edge soft x-ray scattering from lattice-free heliconical molecular ordering: Soft dilative elasticity of the twist-bend liquid crystal phase," *Phys. Rev. Lett.* **2016**, 116, (14). DOI: 10.1103/PhysRevLett.116.147803
16. Tuchband, M. R.; Chen, D.; Horanyi, B.; Shuai, M.; Shen, Y.; Korblova, E.; Walba, D. M.; Kapernaum, N.; Giessemann, F.; Glaser, M. A.; MacLennan, J. E.; Clark, N. A. "Manipulating the twist sense of helical nanofilaments of bent-core liquid crystals using rod-shaped, chiral mesogenic dopants," *Liq. Cryst.* **2016**, 1-9. DOI: 10.1080/02678292.2016.1159345
17. Gim, M.-J.; Kim, H.; Chen, D.; Shen, Y.; Yi, Y.; Korblova, E.; Walba, D. M.; Clark, N. A.; Yoon, D. K. "Air-flow-aligned helical nanofilament (B4) phase in topographic confinement," *Scientific Reports* **2016**, 6, 29111. DOI: 10.1038/srep29111
18. Fernsler, J. G.; Glaser, M. A.; Shao, R.; Coleman, D. A.; MacLennan, J. E.; Link, D. R.; Chang, C.; Lanham, K.; Walba, D.; Boyer, C.; Zasadzinski, J. A.; Clark, N. A. "Aggregation-driven, re-entrant isotropic phase in a smectic liquid crystal material," *Liq. Cryst.* **2016**, 1-15. DOI: 10.1080/02678292.2016.1240835
19. Zhu, C.; Wang, C.; Young, A. T.; Liu, F.; Gunkel, I.; Chen, D.; Walba, D. M.; MacLennan, J. E.; Clark, N. A.; Hexemer, A. "Probing and controlling liquid crystal helical nanofilaments," *Nano Lett* **2015**, 15, 3420-3424.
20. Shen, Y.; Goodhew, L.; Shao, R.; Moran, M.; Korblova, E.; Walba, D. M.; Clark, N. A.; MacLennan, J. E.; Rudquist, P. "Field alignment of bent-core smectic liquid crystals for analog optical phase modulation," *Appl. Phys. Lett.* **2015**, 106, 191101-1 - 191101-4.
21. Ryu, S. H.; Kim, H.; Lee, S.; Cha, Y. J.; Shin, T. J.; Ahn, H.; Korblova, E.; Walba, D. M.; Clark, N. A.; Lee, S. B.; Yoon, D. K. "Nucleation and growth of a helical nanofilament (b4) liquid-crystal phase confined in nanobowls," *Soft Matter* **2015**, 11, (39), 7778-82.
22. Lee, S.; Kim, H.; Tsai, E.; Richardson, J. M.; Korblova, E.; Walba, D. M.; Clark, N. A.; Lee, S. B.; Yoon, D. K. "Multidimensional helical nanostructures in multiscale nanochannels," *Langmuir* **2015**, 31, (29), 8156-61.
23. Lee, S.; Kim, H.; Shin, T. J.; Tsai, E.; Richardson, J. M.; Korblova, E.; Walba, D. M.; Clark, N. A.; Lee, S. B.; Yoon, D. K. "Physico-chemical confinement of helical nanofilaments," *Soft Matter* **2015**, 11, (18), 3653-3659.
24. LaCount, M. D.; Weingarten, D.; Hu, N.; Shaheen, S. E.; van de Lagemaat, J.; Rumbles, G.; Walba, D. M.; Lusk, M. T. "Energy pooling upconversion in organic molecular systems," *J Phys Chem A* **2015**.
25. Fraccia, T. P.; Smith, G. P.; Zanchetta, G.; Paraboschi, E.; Yi, Y.; Walba, D. M.; Dieci, G.; Clark, N. A.; Bellini, T. "Abiotic ligation of DNA oligomers templated by their liquid crystal ordering," *Nat Commun* **2015**, 6, 6424.
26. Chen, D.; Tuchband, M. R.; Horanyi, B.; Korblova, E.; Walba, D. M.; Glaser, M. A.; MacLennan, J. E.; Clark, N. A. "Diastereomeric liquid crystal domains at the mesoscale," *Nat Commun* **2015**, 6, 7763.
27. Bag, S.; Maingi, V.; Maiti, P. K.; Yelk, J.; Glaser, M. A.; Walba, D. M.; Clark, N. A. "Molecular structure of the discotic liquid crystalline phase of hexa-peri-hexabenzocoronene/oligothiophene hybrid and their charge transport properties," *J. Chem. Phys.* **2015**, 143, (14), 144505.
28. Shi, Y.; Fang, G. J.; Glaser, M. A.; MacLennan, J. E.; Korblova, E.; Walba, D. M.; Clark, N. A. "Phase winding of a nematic liquid crystal by dynamic localized reorientation of an azo-based self-assembled mono," *Langmuir* **2014**, 30, (31), 9560-9566.
29. Ryu, S. H.; Shin, T. J.; Gong, T.; Shen, Y.; Korblova, E.; Shao, R.; Walba, D. M.; Clark, N. A.; Yoon, D. K. "Cybotactic behavior in the de vries smectic-a* liquid-crystal structure formed by a silicon-containing molecule,"

Phys. Rev. E **2014**, *89*, (3).

30. Kim, H.; Lee, S.; Shin, T. J.; Korblova, E.; Walba, D. M.; Clark, N. A.; Lee, S. B.; Yoon, D. K. "Multistep hierarchical self-assembly of chiral nanopore arrays," *Proc. Natl. Acad. Sci. U. S. A.* **2014**, *111*, (40), 14342-14347.
31. Kim, H.; Kim, Y. H.; Lee, S.; Walba, D. M.; Clark, N. A.; Lee, S. B.; Yoon, D. K. "Orientation control over bent-core smectic liquid crystal phases," *Liq. Cryst.* **2014**, *41*, (3), 328-341.
32. Hu, N.; Shao, R.; Zhu, C.; Shen, Y.; Park, C.; Korblova, E.; Guerra, C.; Rego, J. A.; Hexemer, A.; Clark, N. A.; Walba, D. M. "Ferroelectric and antiferroelectric odd-even behavior in a tricarbosilane-terminated liquid crystal homologous series," *Chem. Sci.* **2014**, *5*, 1869-1874.
33. Hu, N.; Shao, R.; Shen, Y.; Chen, D.; Clark, N. A.; Walba, D. M. "An electric-field-responsive discotic liquid-crystalline hexa-peri-hexabenzocoronene/oligothiophene hybrid," *Adv. Mater.* **2014**, *26*, (13), 2066-2071.

Patents and Published Applications (Career Total: 32)

1. Walba, D. M. "Liquid crystal devices for information display and photonics applications." US Patent 9,187,500 B2, Nov. 17, 2015, 2015.
2. Walba, D. M. "Organic photovoltaics." US Patent 8,963,140 B2, Feb. 24, 2015.

Other Publications (Career Total: 79)

1. Korblova, E. D.; Rochelle, T.; Guzman, E.; Shao, R.; MacLennan, J. E.; Glaser, M. A.; Clark, N.; Walba, D., Smapf phase, its properties and potential dye alignment. In *Proc spie 9940, liquid crystals xx (conference presentation); Proceedings of spie*, Khoo, I. C., Ed.; 2016; Vol. 9940.
2. Walba, D., Exploring the helical nanofilament phase for organic photovoltaics. *SPIE Photonics West 2015 News-room Article 0058.pdf* 2015, 2015.
3. Walba, D. M., Ferroelectric liquid crystal conglomerates. In *Topics in stereochemistry, materials-chirality*; Green, M. M.; Nolte, R. J. M.; Meijer, E. W.; Denmark, S. E., Eds.; Wiley: New York, 2003; Vol. 24, pp 457-518.
4. Walba, D. M. *The smectic CPG phases and norabow*, International Conference on Chirality and Polarity in the Liquid Crystal Banana Phases, University of Colorado, Boulder, August 24, 2002; University of Colorado, Boulder.

Recent Presentations (Career Total: 372)

1. Contributed Talk, 27th International Liquid Crystal Conference, Kyoto, Japan "High Quality Alignment of the HNF Phase and Selective Chemical Decoration of HNF Surfaces." July 23rd, 2018
2. Invited Talk, ACS National Meeting, Boston History Division, in honor of the 170th Anniversary of Pasteur's Discovery of Molecular Chirality "Symmetry-Breaking in Organic Fluids: The Discovery of the First Fluid Conglomerates." August 20, 2018.
3. Plenary Talk, 16th International Ferroelectric Liquid Crystal Conference, Hong Kong, China "On The Structure and Alignment of the Bent-Core Helical Nanofilament (B4) Phase," December 4, 2017
4. Keynote Lecture, SPIE Symposium on Liquid Crystals XXI, San Diego, California, "High Quality Alignment of the Helical Nanofilament Phase by Micro-confinement in Polymer Channels," August 6, 2017
5. Invited Lecture, Lawrence Berkeley National Laboratory Advanced Light Source User Meeting: Chirality Symmetry Breaking 2016, Berkeley, California, "The Helical Nanofilament Phase: A Liquid Crystal Conglomerate of Nanocrystals," October 5, 2016
6. Invited Lecture, SPIE Symposium on Liquid Crystals XX, San Diego, California, "Host-guest chemistry in the helical nanofilament phase," August 29, 2016.
7. Invited Lecture, International Liquid Crystal Conference, Kent State University, Ohio, "Host-Guest Chemistry and Chiral Recognition with Liquid Crystal Conglomerate Hosts," August 2, 2016

Research Background and Activities

Professor Walba's research is characterized by unusual breadth and interdisciplinary flavor. During the past 39 years, research projects have ranged from studies of metal-oxo promoted diene oxidative cyclization for synthesis of stereochemically complex naturally occurring polyethers, to synthesis and cutting "in half" of a molecular Möbius strip, and development of topological stereochemistry – at the interface between pure math and organic chemistry. Recently, Walba group research has focused on soft materials, in particular ferroelectric liquid crystals (FLCs). Accomplishments in this area include: 1) Development of the first model for the molecular origins of the ferroelectric polarization in FLCs; 2) Design and synthesis of FLCs for second order nonlinear optics (NLO) applications; 3) Design and synthesis of main-chain FLC polymer fibers with interesting supermolecular stereochemistry for NLO applications; 4) Observation by scanning tunneling microscopy of one of the first examples of the formation of a 2-D crystalline conglomerate at the liquid crystal-graphite interface; 5) Discovery (in a team effort driven by the Chemistry group) of the first example of spontaneous reflection symmetry breaking in liquid crystals (in the banana phases), producing liquid conglomerates; 6) Directed design and synthesis of the first ferroelectric banana phase material; 7) The discovery, with Displaytech scientists, that FLC bistable alignment and "V-shaped switching" analog alignment are both manifestations of a deVries smectic layer structure. 8) Synthesis of a "bent-core" LC material producing the first example of smectic liquid crystal phases with C_1 symmetry of the layers; 9) The first example of reversible, in situ LC alignment by the optical ratchet mechanism on photo-active chemisorbed monolayers. 10) Determination and exploitation of the nature of the bent-core Helical Nanofilament (HNF) phase - a novel variety of organic crystalline nanoparticle material. 11) Synthesis of the first benzothieno[3,2-b][1]benzothiophene (BTBT) SmE mesogen possessing a nematic phase at high temperatures, allowing high quality alignment and demonstration of the charge carrier mobility anisotropy in OFETs, which are quite high in the "fast" orientation, 12) Demonstration of "electrostatic V-shaped switching" in a bent-core antiferroelectric SmAP material, thus demonstrating unexpected meta-stability of the ferroelectric SmAP state.

Teaching and Materials Science Outreach Activities

Outreach to the Scientific Community

Professor Walba serves on the Scientific Committee of the biennial International Liquid Crystal Conference series, on the Executive International Scientific Committee of the annual International Symposium on Chiral Discrimination, and on the annual *SPIE Organic Photonics+Electronics – Liquid Crystals* Conference Series. He serves as referee for various scientific journals including the following in 2015: Journal of the American Chemical Society, the Proceedings of the National Academy of Science, Angewandte Chemie, Nature Materials, and Soft Matter.

Classroom Teaching

Professor Walba has taught both semesters of introductory organic chemistry (majors and non-majors), advanced organic chemistry at the graduate level, special topics courses in organic synthesis and in nonlinear optics, and developed and taught the first graduate level organic materials and nanoscience course in the Department of Chemistry and Biochemistry at the University of Colorado, most recently in spring 2013. Since 1992 he has taught organic chemistry to ~ 3,000 undergraduates.

As part of the educational mission of the Soft Materials Research Center (SMRC – an NSF-sponsored Materials Research Science and Engineering Center), Professor Walba has been actively involved in development of a graduate level materials chemistry curriculum. While serving as Chair of the Department of Chemistry and Biochemistry from July 1, 2006 – June 30, 2009, Walba drove the recruiting of two Assistant Professors in the materials field, one working in design, synthesis and applications of organic molecular cages, and the other working on inorganic nanoparticle colloids for renewable energy applications. He also drove the formation of a very successful interdisciplinary Materials Chemistry and Nanoscience

Graduate Program in the Department, which in 2015 led to the formation of the first new Division in the Department since the 1950s, the Materials and Nanoscience Division.

K-12 Outreach

Professor Walba is actively involved in the very strong SMRC K-12 outreach program. He has acted as a Liquid Crystal Wizard for twelve shows in the CU Wizards series; the most recent show was presented in June, 2016. The Liquid Crystal Wizards show has entertained and educated over 2,000 K-6 students and their parents since 1998. He is currently working with Christine Morrow on “Materials Science from CU,” a series of modules tuned to the Colorado middle and high school curriculum. This outreach activity of the SMRC has already provided 400 classroom presentations to over 20,000 Colorado students since 1998.

1. Chen, X., et al., *Polar in-plane surface orientation of a ferroelectric nematic liquid crystal: Polar monodomains and twisted state electro-optics*. Proceedings of the National Academy of Sciences of the United States of America, 2021. **118**(22).