

## C. Wyatt Shields IV, Ph.D.

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### PROFESSIONAL APPOINTMENTS

- 2016-present Postdoctoral Fellow, Chemical & Biomolecular Engineering (Duke and NC State)**  
Raleigh-Durham, North Carolina  
NSF Research Triangle MRSEC, Materials Research Science and Engineering Center  
Advisors: Orlin D. Velev, Ph.D.; Gabriel P. López, Ph.D.; Stefan Zauscher, Ph.D.
- 2016-present Founder & Chief Technical Officer (CTO), Encapsio LLC**  
Durham, North Carolina  
*A materials company that produces silicone particles to encapsulate, protect and controllably release active ingredients*

### EDUCATION

- 2013-2016 Ph.D., Biomedical Engineering, Duke University**  
Durham, North Carolina  
Dissertation: “*Acoustic and magnetic techniques for the isolation and analysis of cells in microfluidic platforms*”  
Advisor: Gabriel P. López, Ph.D.
- 2011-2013 M.S., Biomedical Engineering, Duke University**  
Durham, North Carolina  
M.S., Biomedical Engineering  
Advisor: Gabriel P. López, Ph.D.
- 2007-2011 B.S., Biomedical Engineering, University of Virginia**  
Charlottesville, Virginia  
Graduated with High Distinction  
Advisors: William F. Walker, Ph.D.; Jeffrey J. Saucerman, Ph.D.

### NOTABLE AWARDS

- 2016 Dean’s Award for Excellence in Mentoring, Duke University  
2015 Exceptional Student Award, ISAC (international award to 1 Ph.D. student annually)  
2014 NSF Graduate Research Opportunities Worldwide Award (to study in Lund, Sweden)  
2013 Exceptional Student Award, ISAC (international award to 1 Ph.D. student annually)  
2012 NSF Graduate Research Fellowship  
2011 NSF Research Triangle MRSEC Fellowship  
2011 Undergraduate Research & Design Symposium Finalist  
2011 The Raven Society, UVA  
2010 Tau Beta Pi Engineering Honor Society

**PUBLICATIONS & PATENTS****Peer-reviewed publications** (*Total citations ~ 200 via [Google Scholar](#)*)

17. Fu, L; Bian, C; [Shields IV, CW](#); Cruz, D; López, GP; Charbonneau, P. “Assembly of hard spheres in a cylinder: a computational and experimental study,” (Submitted Oct. 2016).
16. [Shields IV, CW](#); Ohiri, KA; Szott, LM; López, GP. “Translating microfluidics: Cell separation technologies and their barriers to commercialization,” *Cytometry Part B* 2016 (Accepted, in press). DOI: [10.1002/cyto.b.21388](#).
15. Ohiri, KA; Evans, BA; [Shields IV, CW](#); Gutiérrez, RA; Carroll, NJ; López, GP. “Negative acoustic contrast microparticles with high magnetic susceptibilities for bioanalytical applications,” *ACS Applied Materials and Interfaces*. 8(23): 25030–25035. DOI: [10.1021/acsami.6b09591](#).
14. [Shields IV, CW](#); Wang, JL; Ohiri, KA; Essoyan, ED; Yellen, BB; Armstrong, AJ; López, GP. “Microfluidic device for separating cancer cells from whole blood: acoustically enhanced magnetic sorting and single cell templating,” *Lab on a Chip* 2016. 16(19): 3833-3844. DOI: [10.1039/c6lc00719h](#).
13. Johnson, KA; Vormohr, HR; Doinikov, AA; Bouakaz, A; [Shields IV, CW](#); López, GP; Dayton, PA. “Experimental verification of theoretical equations for acoustic radiation force on compressible spherical particles in traveling waves,” *Physical Rev E* 2016. 93(5): 053109. DOI: [10.1103/PhysRevE.93.053109](#).
12. [Shields IV, CW](#); Cruz, DF; Ohiri, KA; Yellen, BB; López, GP. “Fabrication and operation of acoustofluidic devices supporting bulk acoustic standing waves for sheathless focusing of particles,” *Journal of Visualized Experiments* 2016. (109): e53861. DOI: [10.3791/53861](#).
11. Wang, PY;\* [Shields IV, CW](#);\* Zhao, T; Jami, H; López, GP; Kingshott, P. “Rapid self-assembly of shaped microtiles into large, close-packed crystalline monolayers on a solid surface,” *Small* 2016. 12(2): 1309-1314. DOI: [10.1002/sml.201503130](#). (\*Co-First Author)
10. Owens, CE; [Shields IV, CW](#); Cruz, DF; Charbonneau, P; López, GP. “Highly parallel acoustic assembly of microparticles into well-ordered colloidal crystallites,” *Soft Matter* 2016. 12(3): 717-728. DOI: [10.1039/C5SM02348C](#).
9. [Shields IV, CW](#); Reyes, C.; López, GP. “Microfluidic cell sorting: A review of the advances in the separation of cells from debulking to rare cell isolation,” *Lab on a Chip* 2015. 15(5): 1230-1249. DOI: [10.1039/C4LC01246A](#).
8. Gao, L; [Shields IV, CW](#); Johnson, LM; Graves, SW; Yellen, BB; López, GP. “Two-dimensional spatial manipulation of microparticles in continuous flows in acoustofluidic chips,” *Biomicrofluidics* 2015. 9(1): 014105. DOI: [10.1063/1.4905875](#).
7. [Shields IV, CW](#); Livingston, CE; Yellen, BB; López, GP; Murdoch, DM. “Magnetographic array for the capture and enumeration of single cells and cell pairs,” *Biomicrofluidics* 2014. 8(4): 041101. DOI: [10.1063/1.4885840](#). PMID: PMC4188346.
6. [Shields IV, CW](#); Sun, D; Johnson, K; Duval, K; Rodriguez, AV; Gao, L; Dayton, PA; López, GP. “Nucleation and growth synthesis of functional, monodisperse and acoustically programmable particles,” *Angewandte Chemie International Edition* 2014. 53(31): 8070-8073. DOI: [10.1002/anie.201402471](#).
5. [Shields IV, CW](#); Johnson, LM; Gao, L; López, GP. “Elastomeric negative acoustic contrast particles for capture, acoustophoretic transport, and confinement of cells in microfluidic systems,” *Langmuir* 2014. 30(14): 3923-3927. DOI: [10.1021/la404677w](#).
4. Yang, JH; Polanowska-Grabowska, RK; Smith, JS; [Shields IV, CW](#); Saucerman, JJ. “PKA catalytic subunit compartmentation regulates contractile and hypertropic responses to  $\beta$ -adrenergic signaling,” *Journal of Molecular and Cellular Cardiology* 2014. 66 (0): 83-93. DOI: [10.1016/j.yjmcc.2013.11.001](#).
3. Liu, J; [Shields IV, CW](#); Omofoye, O; López, GP. “Programmable anisotropic microparticles for self-assembly applications,” *Materials Research Society Symposium Proceedings* 2014. 1622: 1-6. DOI: [10.1557/opl.2014.38](#).

2. Shields IV, CW; Zhu, S; Yang, Y; Bharti, B; Liu, J; Yellen, BB; Velev, OD; López, GP. “Field-directed assembly of patchy anisotropic microparticles with defined shape,” *Soft Matter* 2013. 9(38): 9219-9229. DOI: [10.1039/C3SM51119G](https://doi.org/10.1039/C3SM51119G).
1. Johnson, LM; Gao, L; Shields IV, CW; Smith, M; Efimenko, K; Cushing, K; Genzer, J; López, GP. “Elastomeric microparticles for acoustic mediated bioseparations,” *Journal of Nanobiotechnology* 2013. 11(22): 1-19. DOI: [10.1186/1477-3155-11-22](https://doi.org/10.1186/1477-3155-11-22).

### Intellectual property

2. Provisional Patent Application (No. 62/325,117) for “Compositions, Systems, and Methods for the Encapsulation and Delivery of a Substance.” Submitted to the Office of Licensing and Ventures at Duke University, IDF #4974. Shields IV, CW; Kirby, N; López, GP. Filing date Apr. 20, 2016.
1. Patent Application No.: 20,150,118,692 for “Acoustically responsive particles,” Johnson, LM; López, GP; Shields IV, CW; Gao, L. Filing date Apr. 30, 2015 (Provisional App. No.: 14/388508).

### FUNDING

#### Large grants (>\$100k)

2014-17 \$544,177 NIH (R21GM111584, López, PI): Acoustic cell sorting instrument\*

\*Provided substantial contribution to writing, full funding awarded to Gabriel P. López, Ph.D.

#### Medium grants (\$10-100k)

2016-17 \$20,000 Big Launch Grant (to N Kirby, W Shields IV, W Day of Encapsio, LLC)  
 2016-17 \$50,000 NC IDEA Grant (to N Kirby, W Shields IV, W Day of Encapsio, LLC)  
 2010-11 \$25,000 Jefferson Trust Grant for The Spectra Journal, UVA

#### Small grants (<\$10k)

2016 \$8,000 SUUP Undergraduate Research Grant with J. White  
 2015-16 \$5,000 SUUP Undergraduate Research Grant with J. Wang  
 2014-15 \$5,000 SUUP Undergraduate Research Grant with C. Bian  
 2014-15 \$5,000 SUUP Undergraduate Research Grant with A. Xiong  
 2014-15 \$3,600 LORD Foundation/Alstadt Grant with C. Owens  
 2014-15 \$9,000 SUUP Undergraduate Research Grant with C. Owens  
 2014 \$10,200 NSF GROW award to study in Sweden for two months  
 2013-14 \$6,000 SUUP Undergraduate Research Grant with D. Sun  
 2013-14 \$3,600 LORD Foundation/Alstadt Grant with O. Omofoye  
 2012-14 \$12,000 SUUP Undergraduate Research Grant with J. Liu

#### Travel awards

2016 \$500 ACS National Meeting from Duke BME Department  
 2015 \$1,000 CYTO Conference from Int’l Society for Advancement Of Cytometry  
 2014 \$750 MRS Conference from Duke Graduate School  
 2014 \$1,000 ACS Colloids Conference from Duke BME Department  
 2013 \$500 IZON Conference from IZON Science Limited  
 2012 \$1,000 USWNet Conference from Duke BME Department

### PRESS FEATURES

2016 Startup (Encapsio) wins the Big Launch Challenge: [Big Launch](#), [ExitEvent](#), [WRAL](#)  
 2016 Startup (Encapsio, formerly microSiO) wins the NC IDEA: [NC IDEA](#), [ExitEvent](#), [WRAL](#)  
 2016 Duke University Dean’s Award for Excellence in Mentoring: [Link to recipient profile](#)  
 2015 *Cytometry A*; Vol. 85A, No. 12: Exceptional Student Award: DOI: [10.1002/cyto.a.22786](https://doi.org/10.1002/cyto.a.22786)  
 2015 Press Feature on 2015 *Lab on a Chip* Review Article: [CytoFluidix](#)  
 2014 NSF Science360 Highlight on 2014 *Angewandte Chemie* Manuscript: [Science360](#)  
 2013 *Cytometry A*; Vol. 83A, No. 7: Exceptional Student Award; DOI: [10.1002/cyto.a.22328](https://doi.org/10.1002/cyto.a.22328)  
 2012 NSF Highlight on grant for acoustic cell sorting (NSF CBET-10-50176)

**PROFESSIONAL ORGANIZATIONS**

- American Chemical Society (ACS)
- Biomedical Engineering Society (BMES)
- International Society for the Advancement of Cytometry (ISAC)
- Materials Research Society (MRS)

**LEADERSHIP**

2012-16	NSF's Research Triangle MRSEC Outreach Leader, Duke
2011-16	Associate Editor, <i>The DukEngineer Journal</i> , Duke
2011-13	Engineering Graduate Student Council, Duke
2009-11	Co-Founder & Editor-in-Chief, <i>The Spectra: Peer-Review Research Journal</i> , UVA
2009-11	Class of 2011 Trustees Councilman Graduation Committee, UVA
2009-10	Class of 2011 Engineering Student Council Representative, UVA
2008-10	Class of 2011 Executive Board, Academic Committee Chair, UVA

**STUDENT MENTORSHIP****Undergraduate students**

	<u>Student</u>	<u>School/Yrs.</u>	<u>Fellowships/Awards</u>	<u>Project</u>
1.	Kelly Chung	Duke '16		Stabilization of silicone microparticles
2.	Alex Scott	UMBC '16	REU Student	Microbot actuation in liquid crystals
3.	Adam Green	Davidson Col. '16		Thermal stability of microspheres
4.	Andrew Murphy	NC State '16-17		Microbots for vesicle deformation
5.	Erica Osta	Texas State '16	REU Student	Slow release of retinol from silicones
6.	Jack White	Duke '16-17	SUUP Fellow	Small molecule gel encapsulation
7.	Jeffrey Wang	Duke '15-16	Pratt & SUUP Fellow	Microfluidic sorting and cell analysis
8.	Amy Xiong	Duke '14-15	SUUP Fellow	Particle assembly in magnetic fields
9.	Amber Zhang	Duke '14-15		ELP-modified elastomeric particles
10.	Ce Bian	Shandong U. '14	SUUP Fellow	Assembly of colloidal microfibrils
11.	Crystal Owens	Duke '14-15	Pratt, SUUP & Altstadt	Acoustic assembly of microparticles
12.	Dana Sun	Duke '13-14	Pratt & SUUP Fellow	Synthesis of silicone colloids
13.	Chris Reyes	Texas State '13	REU Student	Synthesis of gold nanoparticles
14.	C. Livingston	Rice '13	REU Student	Magnetographic array for cell probe
15.	O. Omofoye	Duke '13	Alstadt Fellow	Fabrication of colloidal microtiles
16.	A. Rodriguez	Meredith. C. '13	REU Student	Measuring tri-axial particle stiffness
17.	Maggie Smith	Duke '12-13	Pratt Fellow	Surface modification of silicone
18.	Jonathan Liu	Duke '12-14	SUUP Fellow	Fabrication of anisotropic particles

**Masters students**

19.	Eric Essoyan	Duke '15-16		Guiding colloidal chain sequences
20.	Jin Huang	Duke '15-16		ELP-modified elastomeric particles
21.	Stephan Abdo	Duke '12-13		Acoustic separation of nanoparticles

**ACADEMIC SERVICE & COMMUNITY OUTREACH**

- Invited reviewer for: *Scientific Reports* (Nature), *Lab on a Chip*, *Analytica Chimica Acta*, *Journal of Materials Chemistry C*
- Outreach events (prepared and presented interactive demos on acoustic forces, nanomaterials, thermal conductivity, etc.): *NISE Network NanoDays*, *Science Under the Stars*, *NC Science Festival*, etc. in *Durham, North Carolina*
- Guest lecturer at Riverside High School, Durham, North Carolina at 2015 Fall Speaker Days
- Mathematics and physics tutor, Monticello High School, Charlottesville, Virginia

**PODIUM PRESENTATIONS****Contributed talks**

17. Encapsulation and controlled release of active ingredients from monodisperse, silicone particles. 2016 MRS Fall Meeting & Exhibit iMatSci (Boston, MA). **November 2016**. Shields IV, CW.
16. Acoustic and magnetic methods for the isolation and analysis of biomarkers in microfluidic platforms. Acoustofluidics (Tech. Univ. of Denmark, Copenhagen). **September 2016**. Shields IV, CW; López, GP.
15. Promise of elastomeric particles: Bio- sequestration, separation and delivery. 90<sup>th</sup> Colloid & Surface Science Symposium (Harvard Univ., Boston, MA). **June 2016**. Shields IV, CW; Ohiri, KA; Li, L; Huang, J; White, J; Zhang, Y; Zauscher, S, Chilkoti, A; López, GP.
14. Configurable assembly of microparticles via acoustic standing waves. 90<sup>th</sup> Colloid & Surface Science Symposium (Harvard Univ., Boston, MA). **June 2016**. Shields IV, CW; Owens, CE; Reyes, C; Suthanthiraraj, PPA; Fu, L; Wiley, BJ; Charbonneau, P; López, GP.
13. Acoustic radiation forces for the rapid and programmable assembly of microparticles and nanoparticles. 251<sup>st</sup> ACS National Meeting (San Diego, CA). **March 2016**. Shields IV, CW; Owens, CE; Suthanthiraraj, PPA; Reyes, C; Cruz, DF; Fu, L; Wiley, BJ; Charbonneau, P; López, GP.
12. Peptide-conjugated elastomeric particles for acoustic isolation of biomarkers from whole blood. 251<sup>st</sup> ACS National Meeting (San Diego, CA). **March 2016**. Shields IV, CW; Li, L; Huang, J; Zhang, A; Ohiri, KA; Chilkoti, A; López, GP.
11. Magnetic separation of acoustically focused cancer cells from blood for magnetographic templating and cellular analysis. 251<sup>st</sup> ACS National Meeting (San Diego, CA). **March 2016**. Shields IV, CW; Wang, J; Ohiri, KA; Essoyan, ED; Yellen, BB; Armstrong, AJ; López, GP.
10. Acoustic and magnetic methods for cell sorting and single cell analysis in a microfluidic device. 30<sup>th</sup> CYTO Meeting (Glasgow, Scotland). **June 2015**. Shields IV, CW; Wang, J; Ohiri, KA; Prashanth, P; López, GP.
9. Functional, monodisperse and acoustically programmable silicone gel particles for bioanalytical acoustofluidics. 88<sup>th</sup> Colloid & Surface Science Symposium (Univ. of Pennsylvania, Philadelphia, PA). **June 2014**. Shields IV, CW; Duval, K; Sun, D; López, GP.
8. Acoustically programmable, elastomeric particles. 2014 MRS Fall Meeting & Exhibit iMatSci (Boston, MA). **November 2014**. Shields IV, CW; Johnson, LM; Gao, L; López, GP.
7. Directed assembly of microactuators: field-controlled folding and bending of chains of patchy microcubes. 88<sup>th</sup> Colloid & Surface Science Symposium (Univ. of Pennsylvania, Philadelphia, PA). **June 2014**. Shields IV, CW; Han, K; Bharti, B; Velev, OD; López, GP.
6. Microfluidic systems for acoustic cell sorting. Prostate Cancer Research Forum at Duke Hospital (Durham, NC). **May 2014**. Shields IV, CW; Duval, K; Sun, D; López, GP.
5. Elastomeric particles for acoustophoretic bioseparations. Duke University Pratt Frontiers in Technology Translation (Durham, NC). **May 2014**. Shields IV, CW; Johnson, LM; Gao, L; López, GP.
4. Programmable microparticles synthesized from nucleation and growth for on-chip biosensing. 2<sup>nd</sup> IZON Science Symposium (Boston Univ., Boston, MA). **October 2013**. Shields IV, CW; Sun, D; Gao, L; Johnson, K; Dayton, PA; López, GP.
3. Anisotropic-shaped microparticles for self-assembly applications. 5<sup>th</sup> Self-Assembled Soft Matter Nano-Structures at Interfaces Meeting (New Bern, NC). **September 2013**. Shields IV, CW; Bharti, B; Velev, OD; López, GP.
2. Acoustofluidic cell sorting via negative acoustic contrast capture colloids. 28<sup>th</sup> CYTO Meeting (San Diego, CA). **May 2013**. Shields IV, CW; Johnson, LM; Gao, L; López, GP.
1. Controlling cell decisions by manipulating subcellular signaling. Undergraduate Research and Design Symposium (Univ. of Virginia, Charlottesville, VA). **May 2011**. Shields IV, CW & Smith SJ; Yang, JH; & Saucerman, JJ.

**RESEARCH INTERESTS**

Active matter; biomaterials; analytical chemistry; single cell analysis; soft matter; biosensors; *in vitro* diagnostics; stimuli responsive materials; interfacial phenomena; controlled release; directed cell manipulations; active matter; motile particle systems; lab on a chip devices; colloidal assembly; reconfigurable soft matter

**REFERENCES**

**Available upon request**

1. Gabriel P. López, Ph.D.  
Vice President of Research and Professor, Chemical & Biological Engineering, Univ. of New Mexico
2. Orlin D. Velev, Ph.D.  
INVISTA Professor, Department of Chemical and Biomolecular Engineering, NC State University
3. Stefan Zauscher, Ph.D.  
Sternberg Family Professor, Mech. Engineering & Materials Science, Chemistry, Duke University