DR. ROBERT J. MACFARLANE

Paul M. Cook Assistant Professor

Department of Materials Science and Engineering, MIT

Building 13-5056, 77 Massachusetts Ave. Cambridge, Massachusetts, 02139

Email: rmacfarl@mit.edu Phone: (617) 253-2828

Education

2013 PhD in Chemistry, Northwestern University, Evanston, IL

2006 MS in Inorganic Chemistry Yale University, New Haven, CT

2004 BA in Biochemistry, Willamette University, Salem, OR
(Phi Beta Kappa, Magna cum Laude, with Honors)

Professional Experience

2015-present Massachusetts Institute of Technology, Assistant Professor

2013-2015 California Institute of Technology, Kavli Postdoctoral Fellow

Honors and Awards

2019 Paul M. Cook Assistant Professorship Chair, MIT

2019 3M Non-Tenured Faculty Award

2017 ACS Unilever Award for Outstanding Young Investigator in Colloid & Surfactant Science

2017 NSF CAREER Award

2016-2019 Nanoscale Horizons Community Board Member

2016 AFOSR Young Investigator Program Award

2015-2018 AMAX Career Development Assistant Professorship Chair, MIT

2014 Noble Metal Nanoparticle Gordon Research Conference Selected Presentation

2014 IUPAC Young Investigator Award Honorable Mention

2013 Kavli Nanoscience Institute Post-Doctoral Fellowship

2011 Materials Research Society Gold Graduate Student Award

2011 International Precious Metals Institute Sabin Corp. Graduate Student Award

2010 International Institute for Nanotechnology Outstanding Researcher Award

2009 Ryan Fellowship, Northwestern University

2003 Barry M. Goldwater Scholar

2000 National Merit Scholar

Publications at MIT

1. J. Zhang, P. J. Santos, P. A. Gabrys, S. Lee, C. Liu, **R. J. Macfarlane**
   Self-Assembling Nanocomposite Tectons
   JACS, 2016, *138*, 16228–16231

2. M. X. Wang, S. E. Seo, P. A. Gabrys, D. Fleischman, B. Lee, Y. Kim, H. A. Atwater, **R. J. Macfarlane**, C. A. Mirkin
   Epitaxy: Programmable Atom Equivalents versus Atoms
   ACS Nano, 2017, *11*, 180–185.

3. P. A. Gabrys, S. E. Seo, M. X. Wang, E. Oh, **R. J. Macfarlane**, C. A. Mirkin
   Lattice Mismatch in Crystalline Nanoparticle Thin Films
   Nano Letters, 2018, *18*, 579-585.

4. D. J. Lewis, P. A. Gabrys, **R. J. Macfarlane**
   DNA-Directed Non-Langmuir Deposition of Programmable Atom Equivalents
   Langmuir, 2018, *34*, 14842-14848.

5. P. A. Gabrys, L. Z. Zornberg, **R. J. Macfarlane**
   Programmable Atom Equivalents: Atomic Crystallization as a Framework for Synthesizing Nanoparticle Superlattices
   Small, 2019, *15*, 1970139.

6. P. A. Gabrys, **R. J. Macfarlane**
   Controlling Crystal Texture in Programmable Atom Equivalent Thin Films
   ACS Nano, 2019, *13*, 8452-8460.

7. P. J. Santos, T. C. Cheung, **R. J. Macfarlane**
   Assembling Ordered Crystals with Disperse Building Blocks
   Nano Letters, 2019, *19*, 5774-5780.

8. Y. Wang, P. J. Santos, J. M. Kubiak, X. Guo, M. S. Lee, **R. J. Macfarlane**
   Multistimuli Responsive Nanocomposite Tectons for Pathway Dependent Self-Assembly and Acceleration of Covalent Bond Formation
   JACS, 2019, *141*, 13234-13243.

9. J. M. Kubiak, **R. J. Macfarlane**
   Forming Covalent Crosslinks between Polymer Grafted Nanoparticles as a Route to Highly Filled and Mechanically Robust Nanocomposites
   Advanced Functional Materials, 2019, *29*, 1905168.

10. P. J. Santos, Z. Cao, J. Zhang, A. Alexander-Katz, **R. J. Macfarlane**
    Dictating Nanoparticle Assembly via Systems-Level Control of Molecular Multivalency
    JACS, 2019,*141*, 14624-14632.

11. L. Z. Zornberg, P. A. Gabrys, **R. J. Macfarlane**
    Optical Processing of DNA-Programmed Nanoparticle Superlattices
    Nano Letters, 2019, *DOI: 10.1021/acs.nanolett.9b03258.*

12. D. J. Lewis, L. Z. Zornberg, **R. J. Macfarlane**
    Single Crystal Winterbottom Constructions of Nanoparticle Superlattices
    2019, in review

13. F. Jia, J. Song, J. M Kubiak, P. J. Santos, N. Holten-Andersen, K. Zhang, **R. J. Macfarlane**
    Design and Synthesis of a Bottlebrush Polymer Hydrogel
    2019, in review

Publications prior to MIT

1. H. D. Hill*, **R. J. Macfarlane***, A. J. Senesi, B. Lee, S. Y. Park, C. A. Mirkin
   Controlling the lattice parameters of gold nanoparticle FCC crystals with duplex DNA linkers
   Nano Letters, 2008, *8*, 2341-2344. **Equal Author Contribution*

2. **R. J. Macfarlane**, B. Lee, H. D. Hill, A. J. Senesi, S. Seifert, C. A. Mirkin
   Assembly and organization processes in DNA-directed colloidal crystallization
   PNAS, 2009, *106*, 10493-10498.

3. S. J. Hurst, H. D. Hill, **R. J. Macfarlane**, J. Wu, V. P. Dravid, C. A. Mirkin
   Synthetically Programmable DNA Binding Domains in Aggregates of DNA- Functionalized Gold Nanoparticles
   Small, 2009, *5*, 2156-2161.

4. **R. J. Macfarlane**, C. A. Mirkin
   Colloidal Assembly via Shape Complementarity
   ChemPhysChem, 2010, *11*, 3215-3217.

5. **R. J. Macfarlane**, M. R. Jones, A. J. Senesi, K. Y. Young, B. Lee, C. A. Mirkin
   Establishing the Design Rules for DNA-Mediated Colloidal Crystallization
   Angew. Chem. Int. Ed., 2010, *49*, 4589-4592.

6. M. R. Jones, K. D. Osberg, **R. J. Macfarlane**, M. Langille, C. A. Mirkin
   Templated Techniques for the Synthesis and Assembly of Plasmonic Nanostructures
   Chemical Reviews, 2011, *111*, 3736–3827.

7. M. R. Jones, **R. J. Macfarlane**, B. Lee, J. Zhang, K. L. Young, A. J. Senesi, C. A. Mirkin
   DNA-nanoparticle superlattices formed from anisotropic building blocks
   Nature Materials, 2010, *9*, 913-917.

8. M. R. Jones, **R. J. Macfarlane**, A. E. Prigodich, P. Patel, C. A. Mirkin
   Nanoparticle Shape Anisotropy Dictates the Collective Behavior of Surface-Bound Ligands
   JACS, 2011, *133*, 18865–18869.

9. **R. J. Macfarlane**, B. Lee, M. R. Jones, N. Harris, G. C. Schatz, C. A. Mirkin
   Nanoparticle Superlattice Engineering with DNA
   Science, 2011, *334*, 204-208

10. E. Auyeung, J. Cutler, **R. J. Macfarlane**, M. R. Jones, J. Wu, G. Liu, K. Zhang, K. D. Osberg, C. A. Mirkin
    Synthetically programmable nanoparticle superlattices using a hollow three- dimensional spacer approach
    Nature Nanotechnology, 2012, 7, 24-28.

11. K. L. Young, M. R. Jones, J. Zhang, **R. J. Macfarlane**, R. Esquivel-Sirvent, R. J. Nap, J. Wu, G. C. Schatz, B. Lee, C. A. Mirkin
    Assembly of reconfigurable one-dimensional colloidal superlattices due to a synergy of fundamental nanoscale forces
    PNAS, 2012, *109*, 2240-2245.

12. T. Li, R. Sknepnek, **R. J. Macfarlane**, C. A. Mirkin, M. Olvera de la Cruz
    Modeling the Crystallization of Spherical Nucleic Acid Nanoparticle Conjugates with Molecular Dynamics Simulations
    Nano Letters, 2012, *12*, 2509-2514.

13. E. Auyeung, **R. J. Macfarlane**, C. H. Choi, J. C. Cutler, M. R. Jones, C. A. Mirkin
Transitioning DNA-Engineered Nanoparticle Superlattices from Solution to the Solid State
Advanced Materials, 2012, *24*, 5181-5186.

14. **R. J. Macfarlane**, M. R. Jones, B. Lee, E. Auyeung, C. A. Mirkin
Topotactic Interconversion of Nanoparticle Superlattices
Science, 2013, *341*, 1222-1225.

15. C. Zhang, **R. J. Macfarlane**, K. L. Young, C. H. Choi, L. Hao, E. Auyeung, G. Liu, Z. Zhou, C. A. Mirkin
A general approach to DNA-programmable atom equivalents
Nature Materials, 2013, *12*, 741-746.

16. **R. J. Macfarlane**, M. N. O'Brien, S.H. Petrosko, C. A. Mirkin
Nucleic Acid-Modified Nanostructures as Programmable Atom Equivalents: Forging a New 'Table of Elements'
Angew. Chem. Int. Ed., 2013, *52*, 5688-5698.

17. A. J. Senesi, D. J. Eichelsdoerfer, **R. J. Macfarlane**, M. R. Jones, E. Auyeung, B. Lee, C. A. Mirkin
Stepwise Evolution of DNA-Programmable Nanoparticle Superlattices
Angew. Chem. Int. Ed., 2013, *52*, 6624–6628.

18. Y. Kim, **R. J. Macfarlane**, C. A. Mirkin
Dynamically Interchangeable Nanoparticle Superlattices Through the Use of Nucleic Acid-Based Allosteric Effectors
JACS, 2013, *135*, 10342–10345.

19. S. L. Hellstrom, Y. Kim, J. S. Fakonas, A. J. Senesi, **R. J. Macfarlane**, C. A. Mirkin, H. A. Atwater
Epitaxial Growth of DNA-Assembled Nanoparticle Superlattices on Patterned Substrates
Nano Letters, 2013, *13*, 6084-6090.

20. S. Kewalramani, J. W. Zwannikken, **R. J. Macfarlane**, C-Y. Leung, M. Olvera de la Cruz, C.A. Mirkin, M. J. Bedzyk
Counterion Distribution Surrounding Spherical Nucleic Acid-Au Nanoparticle Conjugates Probed by Small-Angle X-ray Scattering
ACS Nano, 2013, *7*, 11301-11309.

21. A. J. Senesi, D. J. Eichelsdoerfer, K. A. Brown, B. Lee, E. Auyeung, C. H. Choi, **R. J. Macfarlane**, K. L. Young, C. A. Mirkin
Oligonucleotide Flexibility Dictates Crystal Quality in DNA-Programmable Nanoparticle Superlattices
Advanced Materials, 2014, *26*, 7235–7240.

22. **R. J. Macfarlane***, R. V. Thaner*, K. A. Brown, B. Lee, J. Zhang, S. T. Nguyen, C. A. Mirkin
Importance of the DNA 'bond' in programmable nanoparticle crystallization
PNAS, 2014, *111*, 14995-15000. **Equal Author Contribution*

23. **R. J. Macfarlane**, B. Kim, B. Lee, C. M. Bates, S-F. Lee, R. A. Weitekamp, A. B. Chang, K. T. Delaney, G. H. Frederickson, H. A. Atwater, R. H. Grubbs
Improving Brush Polymer Infrared One-Dimensional Photonic Crystals via Linear Polymer Additives
JACS, 2014, *136*, 17374-17377.

24. R. V. Thaner, Y. Kim, T. Li, **R. J. Macfarlane**, S. T. Nguyen, M. Olvera de la Cruz, C. A. Mirkin
Entropy-Driven Crystallization Behavior in DNA-Mediated Nanoparticle Assembly
Nano Letters, 2015, *15*, 5545-5551.

25. Y. Kim, **R. J. Macfarlane**, M. R. Jones, C. A. Mirkin
Transmutable nanoparticles with reconfigurable surface ligands
Science, 2016, *351*, 579-582.

26. R. V. Thaner, I. Eryazici, **R. J. Macfarlane**, K. Brown, B. Lee, S. T. Nguyen, C. A. Mirkin
The Significance of Multivalent Bonding Motifs and "Bond Order" in DNA-Directed Nanoparticle Crystallization
JACS, 2016, *138*, 6119–6122.

Patents

1. **R. J. Macfarlane**, R. H. Grubbs, "Brush Block Copolymer Blends Containing Linear Homopolymers and Random Copolymers", Patent no. CIT-6988-P, Filed on 9/10/2014
2. **R. J. Macfarlane**, J. Zhang, P. J. Santos, P. A. Gabrys, S. Lee, "Self-Assembling Nanocomposite Tectons", International Patent Application No. PCT/US2017/052787, Filed on 9/21/2017

Invited Presentations:

59. "A Systems Approach to Supramolecular Materials"
2020, **Gordon Research Conference on Systems Chemistry**, Newry, ME
58. "Systems-Level Control of Structural Hierarchy"
2020, **Gordon Research Conference on Noble Metal Nanoparticles**, Mount Holyoke, MA
57. "A Systems Approach to Supramolecular Materials"
2019, **City University New York ASRC**, New York, NY
56. "A Systems Approach to Supramolecular Materials"
2019, **Brandeis University**, Waltham, MA
55. "A Systems Approach to Supramolecular Materials"
2019, **Northeastern University**, Boston, MA
54. "A Systems Approach to Supramolecular Materials"
2019, **Boston University**, Boston, MA
53. "DNA-Programmed Interfacial Crystallization"
2019, **ACS Fall Meeting**, San Diego, CA
52. "Systems-Level Control of Structural Hierarchy"
2019, **ACS Fall Meeting**, San Diego, CA
51. "Systems-Level Control of Structural Hierarchy"
2019, **Tel Aviv University**, Tel Aviv, Israel
50. "Systems-Level Control of Structural Hierarchy"
2019, **Weizmann Institute**, Tel Aviv, Israel
49. "A Systems Approach to Supramolecular Materials"
2019, **Gordon Research Conference on Self-Assembly and Supramolecular Chemistry**, Les Diablerets, Switzerland
48. "Systems-Level Control of Structural Hierarchy"
2019, **MRS Spring Meeting**, Phoenix, AZ
47. "Surface-Directed, DNA-programmed Crystallization of Nanoparticles"
2019, **ACS Spring Meeting**, Orlando, FL

46. "Systems-Level Control of Structural Hierarchy"
2019, **ACS Spring Meeting**, Orlando, FL

45. "Systems-Level Control of Structural Hierarchy"
2019, **84th Annual Meeting of the Israeli Chemical Society**, Tel Aviv, Israel

44. "Systems-Level Control of Molecular Multivalency"
2018, **MRS Fall Meeting**, Boston, MA

43. "'Soft' Epitaxy of Programmable Atom Equivalents"
2018, **MRS Fall Meeting**, Boston, MA

42. "Systems-Level Control of Structural Hierarchy"
2018, **Rutgers**, New Brunswick, NJ

41. "Systems-level Control of Structural Hierarchy in Nanocomposites"
2018, **University of Connecticut Polymer Program Symposium**, Storrs, CT

40. "Systems-Level Control of Molecular Multivalency"
2018, **Ryan Fellows Symposium**, Evanston, IL

39. "Holistic Control of Structural Hierarchy in Nanocomposites"
2018, **ACS Fall Meeting**, Boston, MA

38. "Holistic Control of Structural Hierarchy in Nanocomposites"
2018, **Boston Regional Inorganic Chemistry Meeting**, Providence, RI

37. "'Soft' Epitaxy of Programmable Atom Equivalents"
2018, **ACS Spring Meeting**, Boston, MA

36. "Holistic Structural Hierarchy in Nanoparticle Composites"
2018, **ACS Spring Meeting**, Boston, MA

35. "'Soft' Epitaxy of Programmable Atom Equivalents"
2017, **MRS Fall Meeting**, Boston, MA

34. "Programming Material Structure from Molecular to Macroscopic Length Scales"
2017, **6th International Conference on DNA Nanotechnology**, Beijing, China

33. "'Soft' Epitaxy of Programmable Atom Equivalents"
2017, **ACS Fall Meeting**, Washington, DC

32. "Self-Assembling Nanocomposite Tectons"
2017, **ACS Fall Meeting**, Washington, DC

31. "Polymer- and DNA-Directed Assembly of Nanocomposites" *(Plenary Lecture)*
2017, **ACS Colloids Meeting**, New York, NY

30. "Polymer- and DNA-Directed Assembly of Nanocomposites"
2017, **New England Complex Fluids Workshop**, Yale, CT

29. "Polymer- and DNA-Directed Assembly of Nanocomposites"
2017, **Draper Laboratory**, Boston MA

28. "Self-Assembling Nanocomposite Tectons"
2016, **MRS Fall Meeting**, Boston MA

27. "Polymer- and DNA-Directed Assembly of Nanocomposites"
2016, **Soft Materials Structures and Devices Seminar Series**, MIT

26. "DNA Directed Assembly of Programmable Atom Equivalents"
2016, **Nebraska Center for Energy Sciences Research, U. Nebraska**, Lincoln, NE

25. "DNA-Directed Assembly of 'Programmable Atom Equivalents'"
2016, **Micro and Nanotechnologies for Medicine: Emerging Frontiers and Applications, Biomaterials Innovation Research Center**, MIT

24. "DNA-Directed Assembly of 'Programmable Atom Equivalents'"
2016, **Materials Design and Processing from Nano to Mesoscale**, Cornell, NY

23. "Materials by Design: Programmable Assembly at the Nanoscale"
2015, **Stanford University Materials Science Department Seminar**, CA

22. "Materials by Design: Programmable Assembly at the Nanoscale"
2015, **UT Austin**, Austin, TX

21. "Materials by Design: Programmable Assembly at the Nanoscale"
2015, **University of Chicago**, Chicago, IL

20. "Materials by Design: Programmable Assembly at the Nanoscale"
2015, **UC San Diego**, San Diego, CA

19. "Materials by Design: Programmable Assembly at the Nanoscale"
2015, **Penn State University**, University Park, PA

18. "Materials by Design: Programmable Assembly at the Nanoscale"
2015, **UC Berkeley**, Berkeley, CA

17. "Materials by Design: Programmable Assembly at the Nanoscale"
2015, **MIT**, Boston, MA

16. "Materials by Design: Programmable Assembly at the Nanoscale"
2015, **Yale University**, New Haven, CT

15. "Materials by Design: Programmable Assembly at the Nanoscale"
2015, **UW Madison**, Madison, WI

14. "High Fidelity IR 1D Photonic Crystals via Brush Polymer Self-assembly"
2015, **Pacifichem Conference**, Honolulu, HI

13. "Materials by Design: Programmable Assembly at the Nanoscale"
2014, **Boston University**, Boston, MA

12. "Materials by Design: Programmable Assembly at the Nanoscale"
2014, **University of Washington**, Seattle, WA

11. "Materials by Design: Programmable Assembly at the Nanoscale"
2014, **Princeton Chemistry**, Princeton, NJ

10. "Materials by Design: Programmable Assembly at the Nanoscale"
2014, **UCLA**, Los Angeles, CA

9. "Materials by Design: Programmable Assembly at the Nanoscale"
2014, **Texas A&M**, College Station, TX

8. "Materials by Design: Programmable Assembly at the Nanoscale"
2014, **North Carolina State University**, Raleigh, NC

7. "Materials by Design: Programmable Assembly at the Nanoscale"
2014, **UIUC**, Urbana-Champaign, IL

6. "Materials by Design: Programmable Assembly at the Nanoscale"
2014, **Brown University**, Providence, RI

5. “Programmable Self-Assembly with Particles and Polymers”
   2014 **UCSD Nanoengineering Seminar**, San Diego, CA
4. “Ternary Nanoparticle Superlattices via Reversible Symmetry Interconversion”
   2014 **Gordon Research Conference on Noble Metal Nanoparticles**, Mount Holyoke, MA
3. “Nanoparticle Superlattice Engineering with DNA”
   2014 **NYU Soft Matter Institute**, New York, NY
2. “Nanoparticle Superlattice Engineering with DNA”
   2012 **International Beilstein Symposium**, Priem Am Chiemsee, Germany
1. “Nanomaterials Synthesis with DNA-Programmed Nanoparticle Assembly”
   2011, **Energy Frontier Research Center Summit**, Washington, D. C.