Faculty Profile

- Faculty Directory
- Curriculum Vitae
- List of Publications
- Research Group Homepage

Jeffrey Pyun

Associate Professor

Email: jpyun@email.arizona.edu
Building: OC 319
Phone: 520-626-1834

Honors

- Kavli Fellow, US National Academy of Science , 2011
- INSIC Technical Achievement Award for Magnetic Tape, 2009
- Alfred P. Sloan Research Fellowship, 2009
- IBM Faculty Award, 2007
- Office of Naval Research Young Investigator Award, 2007
- NSF CAREER Award, 2007

Education and Appointments

- B.A. 1997, Northwestern University
- Ph.D. 2002, Carnegie Mellon University
- Postdoctoral Fellow 2002-2004, IBM Almaden Research Center / UC Berkeley

Research Interests

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

Research Summary

Organic, Polymer, Materials Chemistry, Nanocomposites, Magnetic and Biomimetic Materials, Self-Assembly

Our research program is focused on the synthesis and characterization of novel polymeric and composite materials, with an emphasis on the control of nanoscale structure. Recent developments in polymer and colloid chemistry offer the synthetic chemist a wide range of tools to prepare well-defined, highly functional building blocks. We seek to synthesize complex materials from a "bottom up" approach via the organization of molecules, polymers and nanoparticles into ordered assemblies.

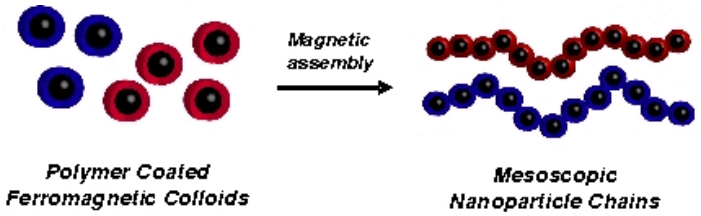
Control of structure on the molecular, nano- and macroscopic regimes offers the possibility of designing specific properties into materials that are otherwise inaccessible. We are particularly interested in compatabilizing interfaces between organic and inorganic matter as a route to combine the advantageous properties of both components. This research is highly interdisciplinary bridging the areas of physics, engineering and materials science with creative synthetic chemistry.

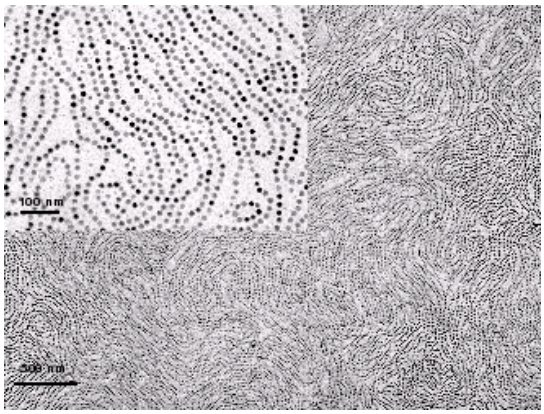
Magnetic Mesoscopic Polymers: Field Induced Assembly of Functional Nanoparticles

We are pursuing a modular synthesis of nanocomposite chains composed of ferromagnetic colloids and functional block copolymers. Controlled and living polymerizations allow the organic chemist to prepare of a wide range of functional block copolymers which will be used as polymeric surfactants in the formation of magnetic colloidal dispersions. In the presence of a magnetic field, these core-shell magnetic nanoparticles align into polymeric chains. The assembled chain can then be locked in by crosslinking of reactive groups attached to the block copolymer surfactant. It is anticipated that the hybridization of these components on the nanoscale will synergistically combine the beneficial film forming properties of organic polymers with the magnetic character of the inorganic colloid. We have developed new synthetic methods using polymeric surfactants to prepare well-defined ferromagnetic nanoparticles and demonstrated that dispersed colloids can be magnetically assembled into mesoscopic 1-D nanoparticle chains, which we refer to as mesoscopic polymer chains, or “meso-polymers.” Functionalization and controlled assembly of these novel building blocks are currently being pursued.

Funding: National Science Foundation, Office of Naval Research, American Chemical Society-Petroleum Research Fund

Collaborators: Tomek Kowalewski (Carnegie Mellon University), Alamgir Karim, Jack Douglas (NIST), Inbo Shim (Kookmin University, Seoul, Korea), Jeanne Pemberton (U of A), Daniel Savin (University of Vermont)





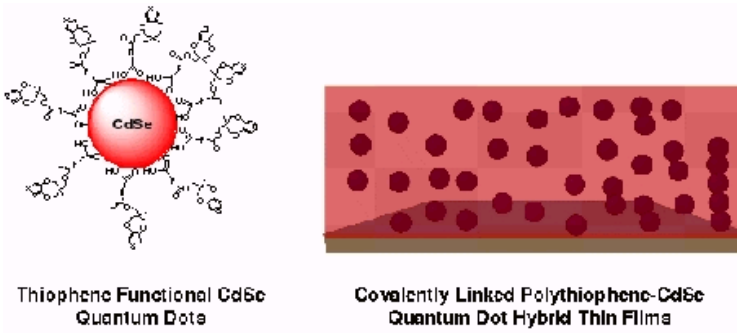
TEM of ferromagnetic polystyrene coated cobalt nanoparticles

Hybrid Nanocomposites for Solar Cells: Conjugated Polymers and Semiconductor Nanoparticles

In collaboration with Neal Armstrong at the U of A, we are investigating the preparation of novel hybrid nanocomposites of CdSe quantum dots with polythiophenes. We are developing novel ligand chemistry to functionalize CdSe quantum dots that will enable electro-copolymerization with thiophene monomers to prepare covalently linked, electroactive materials. In particular, we are investigating the direct modification of transparent conductive oxide materials via electro-polymerization to prepare electrochemically “wired” thin films of polymer-semiconductor hybrids with anodic electrodes. These materials are being investigated for applications as photovoltaic devices and photocatalytic systems for hydrogen generation. This interdisciplinary project combines synthetic organic chemistry, polymers, optical spectroscopy, thin film/surface characterization and device fabrication thru collaboration with a number of research groups at the U of A.

Funding: Department of Energy-Basic Energy Sciences

Collaborators: Neal Armstrong, Zhiping Zheng, Dominic McGrath, Scott Saavedra, Hank Hall, Oliver Monti (U of A)



Thiophene Functional CdSe Quantum Dots

Covalently Linked Polythiophene-CdSe Quantum Dot Hybrid Thin Films

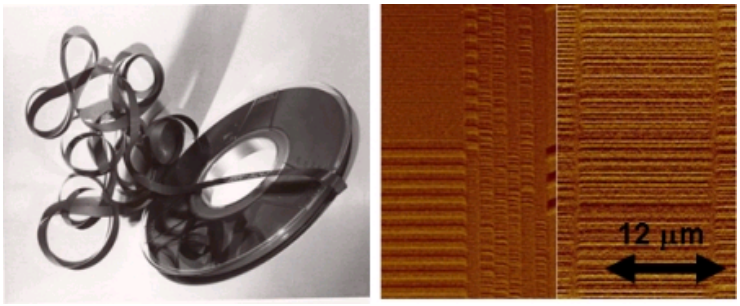
---

Magnetic Nanocomposite Thin Films for Magnetic Tape

We are investigating the preparation of nanostructured thin films of organic polymers and magnetic nanoparticles as novel binder materials for magnetic tape. This technology is critical for long term archival storage, which is still the most reliable and cost-effective media for this application. New synthetic methods to functionalize and protect high moment and coercivity ferromagnetic nanoparticles against corrosion and sintering are being developed using organic polymers and polymeric precursors. This project is also highly collaborative with industrial researchers thru the Information Storage Industry Consortium (INSIC), which include, IBM, HP, SONY and Imation.

Funding: INSIC

Collaborators: Ric Bradshaw, Delia Milliron, Spike Nayaran (IBM), Dave Nikles (University of Alabama)



Selected Publications

- "Utilization of Elemental Sulfur as an Alternative Feedstock for Polymeric Materials: Synthesis, Processing & Electrochemistry," Chung, W.J.; Griebel, J.J.; Kim, E.T.; Yoon, H.S.; Simmonds, A.G.; Jon, H.J.; Wie, J.J.; Nguyen, N.A.; Guralnick, B.W.; Mackay, M.E.; Theato, P.; Glass, R.S.; Char, K.-C.; Pyun, J. *Nature Chemistry* 2012, *submitted*.
- "Synthesis of Polyoctadecyl methacrylate Polymer Brushes via Surface Initiated Atom Transfer Radical Polymerization," Yoo, H.; Kim. B.Y.; Pyun, J. *Appl. Organometallic Chem.* 2012, *submitted*.
- "Directing the deposition of ferromagnetic cobalt onto Pt-tipped CdSe@CdS nanorods: Synthetic and Mechanistic Insights," Hill, L.J.; Bull, M.M.; Sung, Y.; Simmonds, A.G.; Dirlam, P.T.; Richey, N.E.; DeRosa, S.E.; Guin, D.; Shim, I.-B.; Costanzo, P.J.; Pinna, N.; Willinger, M.-G.; Vogel, W.; Char, K.; Pyun, J. *ACS Nano* 2012, *6(10)*, 8632-8645.
- "Functionalization and Patterning of Reactive Polymer Brushes Based on Surface Reversible Addition and Fragmentation Chain Transfer Polymerization," Choi, J.; Schattling, P.; Jochum, F.D.; Pyun, J.; Char, K.; Theato, P. *J. Polym. Sci., Part A: Polym. Chem.* 2012, *50(19)*, 4010-4018.
- "Self Assembly and Colloidal Polymerization of Polymer-Nanoparticle Hybrids into Mesoscopic Chains," Pyun, J. *Angew. Chem. Int. Ed.* 2012, *in press*.
- "Still in Control," Pyun, J. *Nature Materials* 2012, *in press*.
- "Functionalization and Patterning of Reactive Polymer Brushes Based on Surface Reversible Addition and Fragmentation Chain Transfer Polymerization," Choi, J.; Schattling, P.; Jochum, F.D.; Pyun, J.; Char, K.; Theato, P. *J. Polym. Sci., Part A: Polym. Chem.* 2012, *in press*.
- "Controlling Length and Areal Density of Magnetically Actuated Artificial Cilia through the Dipolar Assembly of Ferromagnetic Nanoparticles," Breidenich, J.L.; Wei, M.C.; Clatterbaugh, G.V.; Benkoski, J.J.; Keng, P.K.; Pyun, J. *Soft Matter* 2012, *8*, 5334-5341.
- "Surface Initiated Atom Transfer Radical Polymerization from Indium Tin Oxide Electrodes;

Electrochemistry of Polymer Brushes," Kim, B-Y.; Shallcross, R.C.; Armstrong, N.R.; Kim, H-J.; Chung, W.-J.; Sahoo. R.; Char, K.; Dirlam, P.T.; Costanzo, P.J.; Pyun, J. *ACS Symposium Series: Progress in Controlled Radical Polymerization* 2012, *in press*.

- "Hybrids by Cluster Complex-Initiated Polymerization," Zheng, Z.; Tu, X.; Nichol, G.; Keng, P.Y.; Pyun, J. *Macromolecules* 2012, *in press*.
- "Elemental Sulfur as a Reactive Medium for Au nanoparticles and Nanocomposites," Chung, W.J.; Simmonds, A.G.; Griebel, J.J.; Suh, H.-S.; Kim, E.-T.; Shim, I.-B.; Glass, R.S.; Loy, D.A.; Theato, P.; Sung, Y.-E.; Char, K.; Pyun, J. *Angew. Chem. Int. Ed.*, 2011, *50*, 11409 - 11412 (featured as cover article).
- "Morphological Conversion of Dipolar Core-Shell Au-Co Nanoparticles into Beaded Au-Co3O4 Nanowires," Kim, B.; Shim, I.-B.; Armstrong, N.R.; Sung, Y.-E.; Pyun, *J. J. Mater. Chem.* 2011, *21 (37)*, 14163 - 14166.
- "Dipolar Organization and Magnetic Actuation of Flagella-like Nanoparticle Assemblies," Benkoski, J.J.; Breidenich, J.L.; Uy, O. M.; Hayes, A.T.; Deacon, R.; Land, B.H.; Spicer, J.M.; Keng, P.; Pyun, J. *J. Mater. Chem.* 2011, *21*, 7314 - 7325.
- "Colloidal Polymerization of Polymer Coated Ferromagnetic Nanoparticles into Pt-Co3O4 Nanowires," Keng, P.; Bull, M.M.; Shim, I.-B.; Armstrong, N.R.; Pyun, J. *Chem. Mater.* 2011, *23*, 1120 - 1129.
- "Graphene Oxide as Catalyst: Application of Carbon Materials beyond Nanotechnology," *Angew. Chem. Int. Ed.* 2011, *51*, 46 - 48.
- "Magnetic Self-Assembly of Gold Nanoparticle Chains using Dipolar Core-Shell Colloids," Kim, B.; Shim, I,-B.; Monti, O.A.; Pyun, *J. Chem. Commun.* 2011, *47*, 890 - 892.
- "Mechanically Reinforced Silica Aerogel Nanocomposites via Surface Intiatied Atom Transfer Radical Polymerization," Boday, D.J.; Keng, P.; Muriithi, B.; Pyun, J.; Loy, D.A. *J. Mater. Chem.* 2010, *20*, 6863 - 6865.
- "Synthesis of Polymer Coated Ferromagnetic Nanoparticles in Multi-Gram Quantities with Tunable Variation of Particle Size," Bull, M.M.; Chung, W.-J.; Rasmussen, S.G.; Kim, S.-J.; Shim, I.; Paik, H. J.; Pyun, J. J. *Mater. Chem.* 2010, *20*, 6023 - 6025.
- "Synthesis and Colloidal Polymerization of Dipolar Au-Co Core-Shell Nanoparticles into Au-Co3O4 Nanowires," Kim, B.; Shim, I.; Sahoo, R; Oskan, Z.; Saavedra, S.S.; Armstrong, N.R.; Pyun, J. *J. Am. Chem. Soc.* 2010, *132*, 3234 - 3235.
- "Photoelectrochemical Processes in Polymer Tethered CdSe Nanocrystals," Shallcross, R.C.; D'Ambruoso, G.D.; Pyun, J.; Armstrong, N.R. *J. Am. Chem. Soc.* 2010, *132*, 3234 - 3235.
- "Dipolar Assembly of Ferromagnetic Nanoparticles into Magnetically Driven Artificial Cilia," Benkoski, J.J.; Deacon, R.; Land, B.H.; Baird, L.M.; Breidenich, J.L.; Srinivasan, R.; Clatterbaugh, G.V.; Keng, P.; Pyun, J. *Soft Matter* 2010, *6*, 602 - 609.
- "Ferrocene Functional Polymer Brushes on Indium Tin Oxide via Surface Initiated Atom Transfer Radical Polymerization," Kim, B.; Ratcliff, E.L.; Armstrong, N.R.; Kowalewski, T.; Pyun, J. *Langmuir* 2010, *26*, 2083 - 2092.
- "Efficient CdSe Nanocrystal Diffraction Gratings Prepared by Microcontact Molding," Shallcross, C.R.; Chawla, G.S.; Marrikar, S.; Tolbert, S.; Pyun, J.; Armstrong, N.R. *ACS Nano* 2009, *3*, 3629 - 3363.
- "Colloidal Polymerization of Polymer Coated Ferromagnetic Nanoparticles into Cobalt Oxide Nanowires," Keng, P.; Kim, B.; Shim, I.-B.; Sahoo, R.; Veneman, P.E.; Armstrong, N.R.; Yoo, H.; Permberton, J.E.; Bull, M.M.; Griebel, J.J.; Ratcliff, E.L.; Nebesny, K. G.; Pyun, J. *ACS Nano* 2009, *10,* 3143 - 3157.
- "Oxidation effect in cobalt nanoparticle magnetic fluids," Hong, J.- S.; Pyun, J.; Park, Y.-W.; Kim, C. S.; Shim, I.-B. *IEEE Transactions on Magnetics* 2009, *45*, 2464 - 2466.
- "Lanthanide(III) Doped Magnetite Nanoparticles," De Silva, C.R.; Smith, S.; Shim, I.; Pyun, J.; Zheng, Z. *J. Am. Chem. Soc.* 2009, *131*, 6336 - 6337.
- "pH-Degradable Stabilized Vesicles for Biological Sensing and Delivery," Roberts, D.L.; Bowles, S.E.; Janczak, C.M.; Pyun, J.; Aspinwall, C.A. *Langmuir* 2009, *25*, 1908 - 1910.
- "Synthesis, Assembly and Functionalization of Polymer Coated Ferromagnetic Nanoparticles," Korth, B.D.; Keng, P.; Shim. I.; Tang, C.; Kowalewski, T.; Pyun, J. *ACS Symposium Series, Nanoparticles: Synthesis, Stabilization, Passivation and Functionalization* 2008, *996*, 272 - 285.
- "Self-Assembly of Polymer Coated Ferromagnetic Nanoparticles into Mesoscopic Polymer Chains and Visualization using Fossilized Liquid Assembly," Benkoski, J.J, Bowles, S.E.; Jones, R.A.; Douglas, J.F.; Pyun, J.; Karim, A. *J. Polym. Sci., Part B: Polym. Phys.* 2008, *46*, 2267-2277. (Highlighted in *Materials Views* 2008, *A1 - A8*.)
- "Fabrication of Long CdS Nanowires by Using a Chemical Solution Process," Shim, I.; Choi, D.-H.; Kim, C.-S.; Pyun, J.; Bowles, S.E. *J. Korean Phys. Soc.* 2008, *52*, 332 - 336.
- "Synthesis and Self-Assembly of Polymer Coated Ferromagnetic Nanoparticles," Keng, P.; Shim, I.; Korth, B.D.; Douglas, J.F.; Pyun, J. *ACS Nano* 2007, *4*, 279 - 292.
- "Polythiophene-Semiconductor Nanoparticle Composite Thin Films Tethered to Indium Tin Oxide Substrates via Electropolymerization," Shallcross, R.C.; D'Ambruoso, G.D.; Hall, H; Korth, B.D.; H.K.; Zheng, Z.; Pyun, J.; Armstrong, N. R. *J. Am. Chem. Soc.* 2007, *129*, 11310-11311.
- "Magnetic Assembly and Pyrolysis of Functional Ferromagnetic Nanoparticles into 1-D Carbon Nanostructures," Bowles, S.E.; Wu, W.; Kowalewski, T.; Schalnat, M.; Davis, R.; Pemberton, J.E.; Shim. I.; Korth, B.D.; Pyun, J. *J. Am. Chem. Soc.* 2007*, 129*, 8694 - 8695.
- "Nanocomposite Materials from Functional Polymers and Magnetic Nanoparticles," Pyun, J. *Polym. Rev.* 2007, *47*, 231 - 263.
- "Field induced formation of mesoscopic polymer chains from functional ferromagnetic nanoparticles," Benkoski, J.J, Bowles, S.E.; Korth, Bryan, D.; Jones, R.A.; Douglas, J.F.; Karim, A.; Pyun, J. *J. Am. Chem. Soc.* 2007, *129*, 6291 - 6297.
- "Polymer Encapsulated Metallic and Semiconductor Nanoparticles: Multifunctional Materials with

Novel Optical, Electronic and Magnetic Properties," Pyun, J.; Emrick, T.S. *Macromolecular Engineering: From Precise Macromolecular Synthesis to Macroscopic Materials, Properties and Applications,* Ed. K. Matyjazsewski, L. Leibler, Y. Gnanou, Wiley-VCH, New York, 2007, *vol. 4*, 2409 - 2449.

- "Polymer Coated Ferromagnetic Colloids from Well-Defined Polymeric Surfactants and Assembly into Nanoparticle Chains," Korth, B.D.; Keng, P.; Shim, I.; Bowles, S.; Nebesny, K.; Tang, C.; Kowalewski, T.; Pyun, J. *J. Am. Chem. Soc.* 2006, *128*, 6562.

Send this page by email

Home

Department of Chemistry and Biochemistry at The University of Arizona
P.O. Box 210041, 1306 East University Blvd., Tucson, AZ 85721-0041
Phone: 520.621.6354 Fax: 520.621.8407