

Curriculum Vitae of Hae-Seung Lee

I. ADDRESS:

Macromolecular Science and Engineering Program
Virginia Polytechnic Institute and State University (Virginia Tech)
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II. EDUCATION:

- 2004 - present** Doctorate of Philosophy, Macromolecular Science and
GPA : 3.95 Engineering, Virginia Tech, Blacksburg, VA 24061
Research Topic: Synthesis and Characterization of Multiblock
Copolymer Proton Exchange Membranes for High Temperature
Fuel Cell Application,
Research Advisor: Dr. James E. McGrath
- 1998** Master of Science, Department of Chemistry, Hanyang University,
GPA : 4.00 Seoul, Korea
Thesis Title: "Synthesis of New Silicon Based Photoresists for ArF
Excimer Laser and Their Applications"
Research Advisor: Dr. Yangkyu Han
- 1996** Bachelor of Science, Department of Chemistry, Hanyang
GPA : 3.55 University, Seoul, Korea

III. PROFESSIONAL EXPERIENCE:

- 1998–2004** SAMSUNG SDI Co., Ltd Central R&D Center, Kiheung, Korea,
Senior Researcher, Electronic Material Research Team
- 2002-2003** Synthesis and Applications of Transparent SiO₂ Inorganic Thin
Film with Controlled Nano-structures for AM-OLED (Active
Matrix-Organic Light Emitting Display) Desiccant Materials
- 2001-2002** Synthesis of Organo-Copper Complexes and Their Incorporation
in Polymeric Films for Near Infrared (NIR) Absorbing Filter
Materials for PDP (Plasma Display Panel)
- 1999-2001** Synthesis of Gold Nano-particles in Organic Solvents with
Controlled Size and High Concentrations. Synthesis of Water-
Based Zirconia, Alumina, Titania Precursors for Transparent
Inorganic Thin Film Fabrication. Development of Gold Nano-

- particle Containing Inorganic Thin Film with Tunable Absorption Characteristics for Display Device Applications
- 1999-2000** Synthesis of Indium Tin Oxide(ITO) Precursors for Patternable Conducting Material by Excimer Laser (KrF:248 nm) Ablation
- 1998-1999** Synthesis and Application of Inorganic SiO₂ Sol-gel Precursors for Anti-Reflecting (AR) and Anti-Static (AS) coating for Display Devices

IV. AWARDS and AFFILIATIONS:

- Jan. 2008** Chevron-Phillips Chemical Professional Excellence Travel Awards
- Aug. 2007** The Best Graduate Mentor Award, NSF Summer Undergraduate Research Program (SURP), Virginia Tech
- Spring 1995** Hanyang University Scholarship (based on top 10% in class)
- Spring 1994** Hanyang University Scholarship (based on top 10% in class)
- Spring 1993** Hanyang University Scholarship (based on top 10% in class)
- Fall 2005 – Present** American Chemical Society (ACS)
- Fall 2005 – Present** ACS PMSE division
- Spring 2007 – Present** Electrochemical Society (ECS)
- Fall 2004 to Present** Macromolecules and Interfaces Institute (MII)

V. TEACHING EXPERIENCES:

- 2004 – 2008** American Chemical Society (ACS) Polymer Short-course Program Instructor (Emulsion Polymerization, Melt Polymerization)
- Summer 2007** NSF Summer Undergraduate Research Program Mentor (Materials and Processes for PEM Fuel Cells Division)
- Fall 2004** Graduate Teaching Assistant (GTA), General Chemistry Laboratory, Virginia Tech, Blacksburg, Virginia Tech
- Fall 1996** Graduate Teaching Assistant (GTA), Organic Chemistry Laboratory, Hanyang University, Seoul, Korea
- Spring 1996** Graduate Teaching Assistant (GTA), General Chemistry Laboratory, Hanyang University, Seoul, Korea

VI. SKILLS:

- Synthesis and Characterization
 - Hands on Experience with Various Types of Polymerization: Poly Condensation, Chain Growth Polymerization, Emulsion Polymerization.
 - Design and Synthesis of Functional Monomers and Their Purification
 - Inorganic and Hybrid Material Synthesis by Sol-Gel Routes
 - Metal Nano-particle Synthesis
 - Characterization of Organic, Inorganic Materials

- Photo Lithography Process
- Laser Ablation Process
- Knowledge of Display Devices and their Materials (CRT, OLED, PDP)
- Work Experience with 6 Sigma for 6 years (Green Belt)
- Work Experience with Design of Experiment (DOE)

VII. PUBLICATIONS:

1. **Hae-Seung Lee**, Abhishek Roy, Ozma Lane, Stuart Dunn, and James E. McGrath, “Hydrophilic-Hydrophobic Multiblock Copolymers Based on Poly(arylene ether sulfone) via Low Temperature Coupling Reactions for Proton Exchange Membrane Fuel Cells”, *Polymer*, 49 (2008), 715-723
2. **Lee, Hae-Seung**; Badami, Anand S.; Abhishek Roy; McGrath, James E. “Segmented Sulfonated Poly(arylene ether sulfone)-b-Polyimide Copolymers for Proton Exchange Membrane Fuel Cells. I. Copolymer Synthesis and Fundamental Properties”, *Journal of Polymer Science: Part A: Polymer Chemistry*, Vol. 45, 4879-4890 (2007)
3. **Lee, Hae-Seung**; Roy, Abhishek; Badami, Anand S.; McGrath, James E. Synthesis and characterization of sulfonated poly(arylene ether) polyimide multiblock copolymers for proton exchange membranes. *Macromolecular Research* (2007), 15(2), 160-166.
4. **Lee, Hae-Seung**; Roy, Abhishek; Badami, Anand S.; McGrath, James E. Synthesis of multiblock copolymers based on sulfonated segmented hydrophilic-hydrophobic blocks for proton exchange membranes. *PMSE Preprints* (2006), 95 210-211.
5. **Lee, Hae-Seung**; Einsla, Brian; McGrath, James E. Synthesis and characterization of segmented sulfonated poly(arylene ether)-b-polyimide copolymers as proton exchange membranes. *Preprints of Symposia - American Chemical Society, Division of Fuel Chemistry* (2005), 50(2), 579-580.
6. Kim, Yu Seung; Einsla, Melinda; Hawley, Marilyn; Pivovar, Bryan S.; **Lee, Hae-Seung**; Roy, Abhishek; McGrath, James E. “Multiblock copolymers for low relative humidity fuel cell operation”, *ECS Transactions* (2007), 11(1, Part 1, Proton Exchange Membrane Fuel Cells 7, Part 1), 49-54.
7. Roy, Abhishek; Yu, Xiang; **Lee, Hae-Seung**; Badami, Anand S.; Dunn, Stuart; McGrath, James E. Proton exchange membranes for fuel cell applications. *Polymer Preprints (American Chemical Society, Division of Polymer Chemistry)* (2007), 48(1), 246-247.
8. McGrath, James E.; Roy, Abhishek; **Lee, Hae-Seung**; Yu, Xiang; Badami, Anand; Li, Yanxiang; Wang, Hang. “Multiblock hydrophilic-hydrophobic proton exchange membranes for direct methanol based fuel cell” *ECS Transactions* (2007), 2(24, Direct Methanol Fuel Cells), 55-62.
9. Roy, Abhishek; Hickner, Michael A.; **Lee, Hae-Seung**; Badami, Anand; Yu, Xiang; Li, Yanxiang; Glass, Tom; McGrath, James E. “Transport properties of

- proton exchange membranes”, ECS Transactions (2007), 2(24, Direct Methanol Fuel Cells), 45-54.
10. Roy, Abhishek; **Lee, Hae-Seung**; Badami, Anand S.; Yu, Xiang; Li, Yanxiang; Glass, Thomas E.; McGrath, James E. “Transport properties of multiblock hydrophilic-hydrophobic proton exchange membranes for fuel cells”. Preprints of Symposia - American Chemical Society, Division of Fuel Chemistry (2006), 51(2), 660-661.
 11. Badami, Anand S.; **Lee, Hae-Seung**; Li, Yanxiang; Roy, Abhishek; Wang, Hang; McGrath, James E. Morphological analysis of molecular weight effects upon non- and partially-fluorinated disulfonated poly(arylene ether sulfone)-based random and multiblock copolymers for fuel cells. Preprints of Symposia - American Chemical Society, Division of Fuel Chemistry (2006), 51(2), 612-614.
 12. Yang, Juan; Li, Yanxiang; Wang, Hang; Hill, Melinda; Yu, Xiang; Wiles, Kenton B.; **Lee, Hae-Seung**; McGrath, James E. Viscometric behavior and molecular weight characterization of sulfonated poly(arylene ether sulfone) copolymers. Preprints of Symposia - American Chemical Society, Division of Fuel Chemistry (2005), 50(2), 701-702.
 13. Melinda L. Einsla, Yu Seung Kim, Marilyn Hawley, **Hae-Seung Lee**, James E. McGrath, and Bryan S. Pivovar, “Toward Improved Conductivity of Sulfonated Aromatic Proton Exchange Membranes at Low Relative Humidity” *Chem Mater*, Submitted (2008)
 14. Ozma Lane, **Hae-Seung Lee**, and James E. McGrath, “Morphology and proton transport behavior of multiblock copolymers with Hydrophilic-hydrophobic Sequences for Proton Exchange Membranes” Fuel Cell Preprints (American Chemical Society), Submitted (2008)
 15. **Hae-Seung Lee**, Ozma Lane, and James E. McGrath, “Synthesis and Characterization of Multiblock Copolymers with Hydrophilic-hydrophobic Sequences for Proton Exchange Membranes” Fuel Cell Preprints (American Chemical Society, Division of Polymer Chemistry), Submitted (2008)
 16. Abhishek Roy, **Hae-Seung Lee**, and James E. McGrath, “Hydrocarbon based BPSH-BPS Multiblock Copolymers as Novel Proton Exchange Membranes”, ECS Transactions (2008), Accepted
 17. Anand S. Badami, Abhishek Roy, **Hae-Seung Lee**, Yanxiang Li, and James E. McGrath, “Morphological Investigations of Disulfonated Poly(arylene ether sulfone)-b-Naphthalene Dianhydride-Based Polyimide Multiblock Copolymers as Potential High Temperature Proton Exchange Membranes”, *Journal of Membrane Science*, 2008 (submitted)
 18. Anand S. Badami, Ozma Lane, **Hae-Seung Lee**, Abhishek Roy, and James E. McGrath, “Fundamental Investigations of the Effect of the Linkage Group on the Behavior of Hydrophilic-Hydrophobic Poly(arylene ether sulfone) Multiblock Copolymers for Proton Exchange Membrane Fuel Cells”, *Journal of Membrane Science*, 2008 (submitted)

Technical Reports

1. **Hae-Seung Lee**, Jong-Hyuk Lee, Jeong-Whan Park, Yoon-Hyung Cho, Dong-Sik Zang, “ Low Temperature Crystallization of Structure-Controlled Indium Oxide Sol”, Samsung SDI Technical Report, 1998
2. **Hae-Seung Lee**, Jong-Hyuk Lee, Jeong-Whan Park, Yoon-Hyung Cho, Dong-Sik Zang, “Optical Properties of Metal Nano-Cluster embedded Dielectric Thin Films”, Samsung SDI Technical Report, 2000

VIII. PATENTS ISSUED:

1. Kim, Won-Jong; **Lee, Hae-Seung**; Lee, Jong-Hyuk; Cho, Yoon-Hyeung; Yang, Hyun-Jung. Organic electroluminescent display device. (Samsung SDI Co. Ltd.), U.S. Pat. Appl. Publ. (2005), 9 pp. CODEN: USXXCO US 2005170210 A1 20050804 CAN 143:202642 AN 2005:698184
2. Lee, Jong-Hyuk; **Lee, Hae-Seung**; Cho, Yoon-Hyeung; Kim, Won-Jong; Park, Jin-Woo. Organic electroluminescent device and method of manufacturing the same. (Samsung SDI Co. Ltd.), U.S. Pat. Appl. Publ. (2005), 12 pp. CODEN: USXXCO US 2005046344 A1 20050303 CAN 142:268974 AN 2005:182002
3. Lee, Jong-Hyuk; Cho, Yoon-Hyeung; Yang, Hyun-Jung; Kim, Won-Jong; **Lee, Hae-Seung**. Organic electroluminescence device and manufacturing method thereof. (Samsung SDI Co. Ltd.), U.S. Pat. Appl. Publ. (2005), 14 pp. CODEN: USXXCO US 2005218795 A1 20051006 CAN 143:356358 AN 2005:1077791
4. Lee, Jong-Hyuk; Cho, Yoon-Hyeung; **Lee, Hae-Seung**; Kim, Won-Jong. Organic electroluminescent devices employing an org.-inorg. composite film made of a dehydrated polycondensate of a hydrolyzed trialkoxy metal formed on an upper electrode surface and method of manufacturing the devices. (Samsung SDI Co. Ltd.), U.S. Pat. Appl. Publ. (2004), 7 pp. CODEN: USXXCO US 2004234813 A1 20041125 CAN 142:13481 AN 2004:1019577
5. Cho, Yoon-Hyeung; Lee, Jong-Hyuk; **Lee, Hae-Seung**; Kim, Won-Jong; Choi, Jin-Baek. Organic electroluminescent device and method for manufacturing the same. (Samsung SDI Co. Ltd.), Eur. Pat. Appl. (2006), 29 pp. CODEN: EPXXDW EP 1655792 A1 20060510 CAN 144:442374 AN 2006:442429
6. Lee, Jong Hyuk; Park, Jung Hwan; Jo, Yun Hyung; **Lee, Hai Seung**; Choang, Tong Sik. Cathode ray tube (CRT) having metallic filter and color filter. Jpn. Kokai Tokkyo Koho (2001), 9 pp. CODEN: JKXXAF JP 2001110333 A 20010420 CAN 134:318773 AN 2001:280590
7. Cho, Yun Hyeong; Kim, Won Jong; **Lee, Hae Seung**; Lee, Jong Hyeok. Visibly opaque near-infrared transmitting materials maintaining copper ion to be stable and having improved near-infrared transmitting activity, optical filter comprising the same, and remote controller and security device having the same. (Samsung SDI Co. Ltd.), Repub. Korean Kongkae Taeho Kongbo (2004), CODEN: KRXXA7 KR 2004090278 A 20041022 CAN 145:479967 AN 2006:796391

8. Cho, Yun Hyeong; Kim, Won Jong; **Lee, Hae Seung**; Lee, Jong Hyeok. Near infrared ray absorbing material, optical filter including the same and device for displaying image by incorporating the same. (Samsung SDI Co. Ltd.), Repub. Korean Kongkae Taeho Kongbo (2004), CODEN: KRXXA7 KR 2004052022 A 20040619 CAN 145:220800 AN 2006:727217
9. Jang, Dong Sik; **Lee, Hae Seung**; Sim, Myeon Gi. Surface treatment device of image display element. (Samsung SDI Co. Ltd.), Repub. Korean Kongkae Taeho Kongbo (2001), CODEN: KRXXA7 KR 2001055655 A 20010704 AN 2004:1132577
10. **Lee, Hae Seung**; Lee, Jong Hyeok; Cho, Yun Hyeong; Park, Jeong Hwan. Metal alkoxide composition for forming coating layer on image display device. (Samsung SDI Co. Ltd.), Repub. Korean Kongkae Taeho Kongbo (2003), CODEN: KRXXA7 KR 2003079264 A 20031010 CAN 142:272797 AN 2004:956088
11. Cho, Yun Hyeong; Lee, Jong Hyeok; **Lee, Hae Seung**; Park, Jeong Hwan. Metal alkoxide-based coating composition for forming filter layer on image display device. (Samsung SDI Co. Ltd.), Repub. Korean Kongkae Taeho Kongbo (2003), CODEN: KRXXA7 KR 2003079263 A 20031010 CAN 142:272796 AN 2004:956087
12. Cho, Yun Hyeong; Jang, Dong Sik; **Lee, Hae Seung**; Lee, Jong Hyeok. Method for forming coating film for cathode ray tube panel. (Samsung SDI Co. Ltd.), Repub. Korean Kongkae Taeho Kongbo (2002), CODEN: KRXXA7 KR 2002074747 A 20021004 CAN 142:249139 AN 2004:951224
13. Cho, Yun Hyeong; Jang, Dong Sik; **Lee, Hae Seung**; Lee, Jong Hyeok. Process for producing oxide pigment for forming filter membrane and composition containing the oxide pigment. (Samsung SDI Co. Ltd.), Repub. Korean Kongkae Taeho Kongbo (2002), CODEN: KRXXA7 KR 2002078484 A 20021019 CAN 142:178744 AN 2004:929851
14. Cho, Yun Hyeong; Jang, Dong Sik; **Lee, Hae Seung**; Lee, Jong Hyeok; Park, Jeong Hwan. Composition for forming filter membrane and filter membrane formed from the same. (Samsung SDI Co. Ltd.), Repub. Korean Kongkae Taeho Kongbo (2002), CODEN: KRXXA7 KR 2002011756 A 20020209 CAN 142:122755 AN 2004:913999
15. Cho, Yun Hyeong; Jang, Dong Sik; **Lee, Hae Seung**; Lee, Jong Hyeok; Park, Jeong Hwan. Composition for forming filter membrane and the filter membrane formed from the same. (Samsung SDI Co. Ltd.), Repub. Korean Kongkae Taeho Kongbo (2002), CODEN: KRXXA7 KR 2002010829 A 20020206 CAN 142:122754 AN 2004:913945
16. Cho, Yun Hyeong; Jang, Dong Sik; **Lee, Hae Seung**; Lee, Jong Hyeok; Park, Jeong Hwan. Method for manufacturing cathode ray tube with enhanced contrast. (Samsung SDI Co. Ltd.), Repub. Korean Kongkae Taeho Kongbo (2001), CODEN: KRXXA7 KR 2001086579 A 20010913 CAN 142:186653 AN 2004:911759
17. Cho, Yun Hyeong; Jang, Dong Sik; **Lee, Hae Seung**; Lee, Jong Hyeok; Park, Jeong Hwan. Method for preparing titanium film on glass or plastic plates. (Samsung SDI Co. Ltd.), Repub. Korean Kongkae Taeho Kongbo (2001),

IX. CONFERENCE ORAL PRESENTATIONS:

1. Ho Bum Park, Wei Xie, Benny D. Freeman, Mou Paul, Abhishek Roy, M Sankir, **Hae-Seung Lee**, Judy S. Riffle, and J. E. McGrath, "Chlorine-tolerant desalination membranes" 235th ACS National Meeting, New Orleans, LA, April 6-10, 2008, POLY-312
2. **Hae-Seung Lee**, Abhishek Roy, Anand S. Badami, and James E. E. McGrath "Hydrocarbon BPSH-BPS Multiblock Copolymers as Novel Proton Exchange Membranes" 211th ECS Meeting, May 6-10, 2007, Chicago, Illinois
3. Ho Bum Park, Wei Xie, Benny Freeman, James McGrath, Zhong-Biao Zhang, Guang-Yu Fan, Mou Paul, **Hae-Seung Lee**, "Disulfonated Poly(arylene ether sulfone) Membranes for Desalination", North American Membrane Society 2007, Orlando, Florida, May 12-16, 2007.
4. Roy, Abhishek; Yu, Xiang; **Lee, Hae-Seung**; Badami, Anand S.; Dunn, Stuart; McGrath, James E. "Proton exchange membranes for fuel cell applications", 233rd ACS National Meeting, Chicago, IL, United States, March 25-29, 2007 (2007), POLY-184.
5. **Lee, Hae-Seung**; Roy, Abhishek; Badami, Anand S.; McGrath, James E. "Synthesis of multiblock copolymers based on sulfonated segmented hydrophilic-hydrophobic blocks for proton exchange membranes", 232nd ACS National Meeting, San Francisco, CA, United States, Sept. 10-14, 2006 (2006), PMSE-124.
6. Roy, Abhishek; **Lee, Hae-Seung**; Badami, Anand S.; Yu, Xiang; Li, Yanxiang; Glass, Thomas E.; McGrath, James E. "Transport properties of multiblock hydrophilic-hydrophobic proton exchange membranes for fuel cells", 232nd ACS National Meeting, San Francisco, CA, United States, Sept. 10-14, 2006 (2006), FUEL-173.
7. Badami, Anand S.; **Lee, Hae-Seung**; Li, Yanxiang; Roy, Abhishek; Wang, Hang; McGrath, James E. "Morphological analysis of molecular weight effects upon non- and partially-fluorinated disulfonated poly(arylene ether sulfone)-based random and multiblock copolymers for fuel cells", 232nd ACS National Meeting, San Francisco, CA, United States, Sept. 10-14, 2006 (2006), FUEL-149
8. Badami, Anand S.; **Lee, Hae-Seung**; Li, Yanxiang; Roy, Abhishek; Wang, Hang; McGrath, James E. "Morphological analysis of molecular weight effects based on random and multiblock copolymers for fuel cells", 232nd ACS National Meeting, San Francisco, CA, United States, Sept. 10-14, 2006 (2006), FUEL-039.
9. Roy, Abhishek; **Lee, Hae-Seung**; Badami, Anand S.; Yu, Xiang; Li, Yanxiang; Glass, Thomas E.; McGrath, James E. "Proton conduction under partially hydrated condition for PEMs", 232nd ACS National Meeting, San Francisco, CA, United States, Sept. 10-14, 2006 (2006), FUEL-044.
10. J.E. McGrath, Z. Zhang, G. Fan, M. Sankir, A. Roy, **H.S. Lee**, A. Badami, H.B. Park, B.D. Freeman, "Disulfonated directly copolymerized poly(arylene ether)

- random and block systems: synthesis, characterization, and applications to fuel cells and chlorine resistant reverse osmosis”, North American Membrane Society 2006, Chicago, Illinois, May 12-17, 2006.
11. James McGrath, Zhongbiao Zhang, Guangyu Fan, Mehmet Sankir, Abhishek Roy, **Hae-Seung Lee**, Anand Badami, Ho Bum Park, Benny Freeman, “Novel sulfonated poly(arylene ether) copolymer membranes and their use in reverse osmosis: fundamental water and salt transport study, chlorine stability and anti-fouling characteristics”, North American Membrane Society 2006, Chicago, Illinois, May 12-17, 2006.
 12. **Lee, Hae-Seung**; Einsla, Brian; McGrath, James E. “Synthesis and characterization of segmented sulfonated poly(arylene ether)-B-polyimide copolymers as proton exchange membranes”, 230th ACS National Meeting, Washington, DC, United States, Aug. 28-Sept. 1, 2005, FUEL-071.
 13. Yang, Juan; Li, Yanxiang; Yu, Xiang; Wang, Hang; Wiles, Kenton B.; Hill, Melinda; **Lee, Hae-Seung**; McGrath, J. E. “Viscometric behavior and molecular weight characterization of sulfonated poly(arylene ether sulfone) copolymers”, 230th ACS National Meeting, Washington, DC, United States, Aug. 28-Sept. 1, 2005 (2005), FUEL-136.