Self-assembled structures and applications of DNA hybrid materials

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Education and Training

Sep 2007 – Jan 2011 PhD, Chemistry (promoters: Andreas Herrmann and Klaus Müllen) at the University of Groningen, Groningen, The Netherlands, Dissertation Title: Self-Assembled Structures and Applications of DNA Hybrid Materials.

Jun 2006 – Aug 2007 PhD, Chemistry (promoter: Klaus Müllen, supervisor: Andreas Herrmann) at the Max-Planck-Institute for Polymer Research, Mainz, Germany.

Mar 2004 – Feb 2006 Master, Materials Chemistry (supervisor: Kwang-Yol Kay) at the Dep. of Mol. Sci. and Tech., Ajou University, Suwon, South Korea, Thesis Title: Synthesis and Characterization of Various Electron-donor and acceptor(C_{60}) Dyads.

Feb 2004 Bachelor, Chemistry at the Ajou University, Suwon, South Korea.

Key Achievements

- Exploring large-scale synthesis and fast purification of DNA hybrid materials for further applications
- Introducing new structural combinations of DNA hybrid materials with single-walled nanotubes and virus-like particles
- Set-up of Prof. Herrmann's research group, Polymer Chemistry and Bionengineering (PCBE), and all corresponding laboratory facilities in the University of Groningen

Special Knowledges

- Supramolecular self-assembly of nanoarchitectures: nucleic acids, gold nanoparticles, carbon nanotubes, proteins, polymer amphiphiles
- Chemical synthesis of modified and native oligonucleotides, their purification and characterization: solid-phase DNA/RNA synthesis, analytical/preparative HPLC and gel electrophoresis

- Design and synthesis of small compounds and macromolecules: conventional polymers, C_{60} derivatives, π-conjugated systems
- Loading and labeling of polymeric and DNA micelles
- Characterization of nanoobjects: dynamic light scattering (DLS), tunneling electron microscopy (TEM), atomic force microscopy (AFM), Förster resonance energy transfer (FRET)
- Scientific programming skills: MATLAB, PHP, database

List of Publications

Journal articles:

[1] **Kwak M**; Gao J; Prusty DK; Musser AJ; Markov VA; Tombros N; Stuart MCA; Browne WR; Boekema EJ; ten Brinke G; Jonkman HT; van Wees BJ; Loi MA; Herrmann A, "DNA Block Copolymer Doing It All: From Selection to Self-Assembly of Semiconducting Carbon Nanotubes", *Angew. Chem. Int. Ed.*, **2011**, accepted.

[2] **Kwak M**; Herrmann A, "Nucleic Acid-Organic Polymer Hybrid Materials: Synthesis, Superstructures and Applications", *Angew. Chem. Int. Ed.*, **2010**, *49*, 8574–8587. DOI: 10.1002/anie.200906820

[3] **Kwak M**; Minten IJ; Anaya D-M; Musser AJ; Brasch M; Nolte RJM; Müllen K; Cornelissen JJLM; Herrmann A, "Virus-like Particles Templated by DNA Micelles: A General Method for Loading Virus Nanocarriers", *J. Am. Chem. Soc.*, **2010**, *132*, 7834–7835. DOI: 10.1021/ja101444j

[4] **Kwak M**; Musser AJ; Lee J; Herrmann A, "DNA-Functionalised Blend Micelles: Mix and Fix Polymeric Hybrid Nanostructures", *Chem. Commun.*, **2010**, *46*, 4935–4937. DOI: 10.1039/C0CC00855A

[5] Ayaz MS†; **Kwak M**†; Alemdaroglu FE; Wang J; Berger R; Herrmann A, "Synthesis of DNA Block Copolymers with Extended Nucleic Acid Segments by Enzymatic Ligation: Cut and Paste Large Hybrid Architectures", *Chem. Commun.*, **2011**, published online († equal contribution). DOI: 10.1039/C0CC04746E

[6] Anaya M; **Kwak M**; Musser AJ; Müllen K; Herrmann A, "Tunable Hydrophobicity in DNA Micelles: Design, Synthesis and Characterization of a New Family of DNA Amphiphiles", *Chem.-Eur. J.*, **2010**, *16*, 12852–12859. DOI: 10.1002/chem.201001816

[7] Gao J; **Kwak M**; Wildeman J; Herrmann A, Loi MA, "Effectiveness of Sorting Single-Walled Carbon Nanotubes by Diameter Using Polyfluorene Derivatives", *Carbon*, **2011**, *49*, 333–338. DOI: 10.1016/j.carbon.2010.09.036

[8] Sowwan M; Faroun M; Mentovich E; Ibrahim I; Haboush S; Alemdaroglu FE; **Kwak M**; Richter S; Herrmann A, "Polarizability of DNA Block Copolymer Nanoparticles Observed by Electrostatic Force Microscopy", *Macromol. Rapid Commun.*, **2010**, *31*, 1242–1246. DOI: 10.1002/marc.200900904

[9] El-Khouly ME; Kim JH; **Kwak M**; Choi CS; Ito O; Kay KY, "Photoinduced Charge Separation of the Covalently Linked Fullerene-triphenylamine-fullerene Triad. Effect of Dual Fullerenes on Lifetimes of Charge-separated States", *Bull. Chem. Soc. Jpn.*, **2007**, *80*, 2465–2472. DOI: 10.1246/bcsj.80.2465

Book chapter:

Zimmermann J; **Kwak M**; Musser AJ; Herrmann A, "Amphiphilic DNA block Copolymers: Nucleic Acid-polymer Hybrid Materials for Diagnostics and Biomedicine", in "Methods in Molecular Biology: Bioconjugation Protocols", Springer, Heidelberg, **2010**, in press (series cited as a journal article)

Patents:

Kay KY; **Kwak M**; Kim JH; Han KJ, "Hexaphenylbenzenes with Aminostyryl Moiety for Organic Electroluminescent Materials", ISU Chemicals, 1020050112724, **2007**, Korean Patent.

Kay KY; **Kwak M**; Kim JH; Jung JH; Han KJ, "Polyphenylbenzenes for Organic Electroluminescent Materials", ISU Chemicals, 1020050109981, **2007**, Korean Patent.

Kay KY; **Kwak M**; Kim JH; Jung JH; Han KJ, "Hexabenzocoronene derivatives for Organic Electroluminescent Materials", ISU Chemicals, 1020050110535, **2007**, Korean Patent.

List of Presentations

Lecture and oral presentations:

Kwak M; Herrmann A, "DNA Block Copolymers for Applications in Electronics and Biomedicine" , 10th Dutch Polymer Days, Veldhoven, The Netherlands, 16 February **2010** (plenary keynote lecture).

Kwak M; Alemdaroglu FE; Herrmann A, "DNA Block Copolymers, Versatile Hybrid Materials: from Synthesis to Applications" , 103rd meeting of the Korean Chemical Society, Seoul, South Korea, 17 April **2009**.

Kwak M; Herrmann A, "DNA Hybrid Materials: Current research of DNA block copolymers and DNA surfactants" , Pore Meeting of the Zernike Institute for Advanced Materials, Groningen, The Netherlands, 11 February **2009**.

Kwak M; Herrmann A, "Single-Walled Nanotube Dispersion with DNA Block Copolymers" , 9th Dutch Polymer Days, Luntern, The Netherlands, 2 February **2009**.

Kwak M; Singh R; Herrmann A, "DNA Block Copolymers" , Kick-off Consortium Meeting of the Electronically Programmable Chemical Cell Project (ECCELL, EU sponsored project in Framework Programme 7), Venice, Italy, 20 October, **2008**.

Selected poster presentations:

Musser AJ; **Kwak M**; Lee J; Herrmann A, "Stabilized Micellar Nanostructure of DNA-b-PPO and Pluronics Block Copolymer Blends", 10th Dutch Polymer Days, Veldhoven, The Netherlands, 15-16 February **2010**.

Kwak M; Herrmann A, "A General Strategy for the Loading of Virus-like Particles Mediated by DNA Block Copolymer Micelles", International Advisory Panel Meeting of the Zernike Institute for Advanced Materials, Groningen, The Netherlands, 11 December **2009**.

Kwak M; Herrmann A, "Single-Walled Nanotube Dispersion with DNA Block Copolymers", Vlieland Conference of the Zernike Institute for Advanced Materials, Vlieland, The Netherlands, 28 March **2009**.

Kwak M; Alemdaroglu FE; Herrmann A, "DNA Block Copolymers - Versatile Hybrid Materials", Minerva School on Biological and Bio-inspired Materials, Berlin, Germany, **2007**.

Kwak M; Kay KY, "Intramolecular Charge-Transfer Interactions in Two New Dyads Based on C_{60} and Bis(N,N-dimethyl or diphenyl substituted) Aniline Donor", 203th National Meeting and Exposition of the American Chemical Society, Washington DC, U.S.A., **2005**.

Kwak M; Kay KY, "Synthesis and Characterization of Novel Triphenylamine(donor)-Fullerene(acceptor) Dyads", Joint Meeting of the Electro Chemical Society, Honolulu, U.S.A., **2004**.

Four more poster presentations in Korean Chemical Society Meetings in 2004-2005.

Personal Information

Born on February 15, 1976 in Seoul, South Korea.

Married, no child.

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