

SANDEEP S. KARAJANAGI, PhD

EDUCATION

Doctor of Philosophy (PhD)

(July 2006)

Major: Chemical and Biological Engineering

GPA: 3.8

Rensselaer Polytechnic Institute (RPI), Troy, NY, USA

Thesis Advisors: Dr. Jonathan S. Dordick and Dr. Ravi S. Kane

Thesis Title: Protein functionalized carbon nanotubes as functional nanomaterials.

Bachelors of Engineering (B.E.)

(June 2001)

Major: Chemical Engineering

Ranked 4th/ 500 in the University

D. J. Sanghvi College of Engineering, University of Mumbai (Bombay)

WORK EXPERIENCE

Assistant Biomedical Engineer (equivalent to Scientist)

Massachusetts General Hospital, Center for Laryngeal Surgery and Voice Rehabilitation **(Fall 2008 – Present)**

Instructor

Harvard Medical School

(Fall 2008 – Present)

- **Translation of biomaterials for soft tissue augmentation/ repair from bench to bedside**

- Invented novel injectable biomaterials for the treatment of scarred vocal folds
- Evaluation and development of pathways to get FDA approval for biomaterials
- Filing for an Investigational Device Exemption (IDE) with the FDA
- Working with a Contract Manufacturing Organization (CMO)

Postdoctoral Research Associate, Prof. Robert Langer Laboratory

Massachusetts Institute of Technology, Dept. of Chemical Engineering

Massachusetts General Hospital, Center for Laryngeal Surgery and Voice Rehabilitation **(Fall 2006-Fall 2008)**

- **Tissue engineering of human vocal fold tissue using adult stem cells**

- Preparation of polyethylene glycol (PEG) based scaffolds for attachment, proliferation, and differentiation of adipose derived stem cells (ADSCs).
- Preparation of cellular constructs using ADSCs and collagen, hyaluronic acid (HA), and elastin for implantation into a scarred human vocal fold tissue.

- **Preparation of hybrid biomaterials for applications in medicine**

- Preparation of soft hydrogels composed of synthetic polymers and naturally derived peptides and proteins for soft-tissue augmentation especially for augmenting/ replacing the vocal fold tissue.
- Evaluation of the safety and efficacy of the biomaterials using *in vitro*, *ex vivo*, and *in vivo* models.

- **Delivery of growth factors using biodegradable polymers**

- Preparation of degradable poly-lactic glycolic acid (PLGA) microspheres for delivery of angiogenic growth factors.

RESEARCH EXPERIENCE

Graduate Research Assistant

(Fall 2001-Fall 2006)

Rensselaer Polytechnic Institute, Dept. of Chemical and Biological Engineering

- **Preparation and characterization of nanomaterials functionalized with biomolecules**

- Covalent and noncovalent functionalization of carbon nanotubes with proteins, followed by characterization using enzyme kinetic analysis, FT-IR spectroscopy, AFM, SEM, and TEM.

- Discovery of carbon nanotube solubilization using proteins, characterization of water-soluble SWNT-proteins using UV-Vis Spectroscopy, Raman Spectroscopy, AFM, and TEM.
- **Protein structure, function, and stability on single-walled carbon nanotubes (SWNTs) and nanoparticles**
 - Elucidating the structure and activity of enzymes adsorbed onto SWNTs using enzyme kinetic analysis, AFM, and FT-IR spectroscopy.
 - Discovery of enhanced stability of proteins adsorbed onto nanoscale materials, characterization using enzyme kinetic analysis in aqueous and non-aqueous media, AFM, SEM followed by theoretical modeling of the results.
- **Directed assembly of carbon nanotubes**
 - Assembly of enzyme-functionalized carbon nanotubes at liquid-liquid interfaces for interfacial biotransformations.
- **Preparation of high-density enzyme containing matrices, biocatalytic nanocomposites, and nanotube-nanoparticle conjugates/ nanowires using biomineralization**
 - Immobilization of enzymes on vertically aligned carbon nanotube arrays and silicon nanocolumns for preparing high-density enzyme containing matrices.
 - Preparation of carbon nanotube-enzyme-polymer composite materials for applications as films that resist protein/ microbial fouling.
 - Biomineralization on protein-functionalized SWNTs to form inorganic nanoparticles on nanotubes and nanotube-templated nanowires.

Undergraduate Research

(Summer 2000)

Advisor: Dr. D. D. Ravetkar, National Chemical Laboratory, Pune, India

- **Design of a heat exchanger in the presence of non-condensable gases**

PUBLICATIONS

1. Lopez-Guerra, Gerardo; Kobler, James B.; Park, Hyounghshin; Heaton, James T.; Zeitels, Steven M.; Kumai, Yoshihiko; **Karajanagi, Sandeep S.**; Mehta, Daryush D.; Hillman, Robert E.; “A ferret in-vivo phonation model to assess phonosurgical interventions”, accepted, *The Laryngoscope*, 2008.
2. Kumai, Yoshihiko; Kobler, James B.; Park, Hyounghshin; **Karajanagi, Sandeep S.**; Lopez-Guerra, Gerardo; Herrera, Victoria; Zeitels, Steven M.; “Cross-talk between adipose-derived stem cells and vocal fold fibroblasts in vitro”, *The Laryngoscope*, 119(4), 799-805, 2009.
3. **Karajanagi, Sandeep S.**; Asuri, Prashanth; Sellitto, Edward; Eker, Bilge; Bale, Shyam Sunder; Kane, Ravi S.; Dordick, Jonathan S.; “Protein-carbon nanotube conjugates”, *ACS Symposium Series 986*, Biomolecular Catalysis: Nanoscale Science and Technology, 2007. (**Book Chapter**)
4. Bale, Shyam Sundhar; Asuri, Prashanth; **Karajanagi, Sandeep S.**; Dordick, Jonathan S.; Kane, Ravi S. “Protein-directed formation of silver nanoparticles on carbon nanotubes”, *Advanced Materials*, 19, 3167-3170, 2007.
5. Asuri Prashanth; **Karajanagi, Sandeep S.**; Vertegel, Alexey A.; Dordick, Jonathan S.; Kane, Ravi S.; “Enhanced stability of enzymes adsorbed onto nanoparticles”, *Journal of Nanoscience and Nanotechnology*, 7, 1675-1678, 2007.

6. Asuri Prashanth; **Karajanagi, Sandeep S.**; Dordick, Jonathan S.; Kane, Ravi S.; “Polymer-nanotube-enzyme composites as active antifouling films”, *Small*, 3, 50-53, 2007. **(A separate article was written on this work in Nature Nanotechnology.)**
7. Asuri, Prashanth; Bale, Shyam Sundhar; **Karajanagi, Sandeep S.**; Kane, Ravi S. “The protein-nanomaterial interface”, *Current Opinion in Biotechnology*, 17, 562-568, 2006.
8. **Karajanagi, Sandeep S.**[†]; Asuri, Prashanth[†]; Sellitto, Edward; Kim, Dae-Yun; Kane, Ravi S.; Dordick, Jonathan S.; “Water-soluble carbon nanotube-enzyme conjugates as functional biocatalytic formulations”, *Biotechnology and Bioengineering*, 95, 804-811, 2006. ([†] **Equal contribution**).
9. **Karajanagi, Sandeep S.**; Yang, Hoichang; Asuri, Prashanth; Sellitto, Edward; Dordick, Jonathan S.; Kane, Ravi S.; “Protein-assisted solubilization of single-walled carbon nanotubes”, *Langmuir*, 22, 1392-1395, 2006. **(Citations to date = 78) (This paper was one of the most-cited papers in Langmuir in 2006).**
10. Asuri, Prashanth; **Karajanagi, Sandeep S.**; Yang, Hoichang; Kane, Ravi S.; Dordick, Jonathan S. “Increasing protein stability through control of the nanoscale environment”, *Langmuir*, 22, 5833-5836, 2006.
11. Asuri, Prashanth; **Karajanagi, Sandeep S.**; Kane, Ravi S.; Dordick, Jonathan S. “Carbon nanotubes as nanoscale conveyors for interfacial biocatalysis”, *Journal of the American Chemical Society*, 128, 1046-1047, 2006.
12. **Karajanagi, Sandeep S.**; Vertegel, Alexey A.; Kane, Ravi S.; Dordick, Jonathan S.; “Structure and function of enzymes adsorbed onto single-walled carbon nanotubes”, *Langmuir*, 20, 11594-11599, 2004. **(Citations to date = 90) (This article was referenced in an Editorial article in Proceedings of the National Academy of Sciences.)**
13. Yim, Tae-Jin; Kim, Dae-Yun; **Karajanagi, Sandeep S.**; Lu, Toh-Ming; Kane, Ravi; Dordick, Jonathan S.; “Si Nanocolumns as novel nanostructured supports for enzyme immobilization”, *Journal of Nanoscience and Nanotechnology*, 3, 479-482, 2003.

MANUSCRIPTS IN PREPARATION

1. **Karajanagi, Sandeep S.**; Park, Hyounghshin; Kobler, James B.; Lopez-Guerra, Gerardo; Heaton, James T.; Hillman, Robert; Zeitels, Steven M.; Langer, Robert S. “Soft hydrogels for restoring pliability to a scarred vocal fold”.
2. **Karajanagi, Sandeep S.**; Park, Hyounghshin; Langer, Robert S. “Polyethylene glycol: Applications in Biotechnology and Medicine”.

PATENTS

1. **Karajanagi, Sandeep S.**; Kane, Ravi S.; Asuri, Prashanth; Dordick, Jonathan S.; “Enhanced stability of proteins immobilized on nanoparticles”. (US Patent pending)
2. **Karajanagi, Sandeep S.**; Park, Hyounghshin; Kobler, James B.; Heaton, James T.; Hillman, Robert; Zeitels, Steven M.; Langer, Robert S.; “Soft hydrogels with adjustable properties for soft tissue augmentation and replacement”. (US Patent pending)

PROFESSIONAL SKILLS

- **Research areas:** Biomaterials, stem cell engineering, regenerative medicine, nanomaterials, tissue engineering, soft-tissue augmentation and repair, biomedical devices, drug delivery, aqueous and non-aqueous biocatalysis, protein structure and function, bioconjugate chemistry, functionalization and

characterization of nanomaterials, biocatalytic polymer nanocomposites, carbon nanotubes, biomineralization.

- **Commercialization experience:** Active involvement in invention and translation of biomaterials from bench into the clinic; Experience in evaluating and developing pathways for getting FDA approval for biomaterials, knowledge of filing for an Investigational Device Exemption (IDE), and experience in working with a Contract Manufacturing Organization (CMO).
- **Laboratory skills:** Extensive experience with various spectroscopic techniques such as UV/ Vis/ NIR, Raman, Circular Dichroism, and FT-IR spectroscopy; microscopy techniques such as Light and Fluorescence Microscopy, Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), and Transmission Electron Microscopy (TEM); biological techniques such as mammalian cell culture, FACS, RT-PCR, Immunohistochemistry, ELISA and SDS-PAGE analysis; Experience with animal studies; other analytical techniques such as Nuclear Magnetic Resonance (NMR) and Differential Scanning Calorimetry (DSC).
- **Computer skills:** OS-Windows; programming -FORTRAN, C, MATLAB; packages- MS Office.

TEACHING EXPERIENCE

Graduate Teaching Assistant

(Fall 2002)

Rensselaer Polytechnic Institute, Dept. of Chemical and Biological Engineering

- Worked as a teaching assistant for an undergraduate course “Material, Energy, and Entropy Balances”; responsibilities involved mentoring and teaching undergraduates.

Mentoring

(Spring 2005-Present)

- Mentored 9 undergraduate students and 2 research assistants as they completed their research under my guidance.

AWARDS and HONORS

- **Invited Reviewer** for the peer-reviewed scientific journals “Biotechnology and Bioengineering”, “Acta Biomateriala”, “Nanotechnology”, “Smart Materials and Structures”, and “New Journal of Physics”.
(Spring 2007-present)
- **Best Poster Award (3rd Prize)**, AIChE Annual Meeting, Cincinnati, OH. (Fall 2005)
- **Founders Award of Excellence**, given to outstanding students at RPI. (Fall 2004)
- **Best Poster Award (3rd Prize)**, NY Nanotech Meeting, Albany. (Fall 2004)
- **Best Poster Award (3rd Prize)**, NY Nanotech Meeting, Troy. (Fall 2002)
- **Howard P. Isermann Graduate Fellowship**, RPI. (Fall 2001)
- **Ranked 4th in the University of Mumbai**, in about 500 students during B.S. (June 2001)

CONFERENCE PRESENTATIONS AND POSTERS

- Park, Hyounghsin; **Karajanagi, Sandeep S.**; Kobler, James B.; Heaton, James T.; Langer, R. S.; Zeitels, Steven M. “Vocal fold tissue engineering using adipose derived stem cells: effect of scaffold materials on gene expression”, American Head and Neck Society Annual Meeting, San Francisco, CA, July 2008.
- **Karajanagi, Sandeep S.**[†]; Asuri, Prashanth[†]; Sellitto, Edward; Kim, Dae-Yun; Kane, Ravi S.; Dordick, Jonathan S.; “Multi-walled carbon nanotube-enzyme conjugates as biocatalytic nanomaterials”, AIChE Annual Meeting, Cincinnati, OH, November 2005. (Award winning poster) († Equal contribution)

- **Karajanagi, Sandeep S.**; Yang, Hoichang; Asuri, Prashanth; Sellitto, Edward; Kane, Ravi S.; Dordick, Jonathan S.; “Preparation of individually dispersed single-walled carbon nanotube-protein conjugates”, AIChE Annual Meeting, Cincinnati, OH, November 2005. (Poster)
- Dordick, Jonathan S.; Asuri, Prashanth; Kane, **Karajanagi, Sandeep S.**; Ravi S.; “Engineering protein activity and stability through control of the nanoscale environment”, AIChE Annual Meeting, Cincinnati, OH, November 2005.
- **Karajanagi, Sandeep S.**; Kim, Dae-Yun; Kane, Ravi; Dordick, Jonathan S.; “Enzyme-nanotube conjugates as functional nanomaterials”, ACS Annual Meeting, Anaheim, CA, March 2004.
- **Karajanagi, Sandeep S.**; Kim, Dae-Yun; Kane, Ravi; Dordick, Jonathan S.; “Enzyme immobilization on carbon nanotubes for generating biocatalytic nanomaterials”, AIChE Annual Meeting, San Francisco, CA, November 2003.

COURSES AND PROJECTS/ PROPOSALS

Specialized Courses

- Advanced Biochemical Engineering, Molecular Separations, Biosurfaces, Molecular Biochemistry, Mathematical Methods in Chemical Engineering, Chromatographic Separation Processes, Medicinal Chemistry, Advanced Fluid Mechanics, Advanced Chemical Reactor Design.

Projects/ Proposals

- “Combinatorial Biosynthesis of Therapeutics Using PKS Pathway” – Medicinal Chemistry, Fall 2003.
- A research proposal on “Polymeric Drug Delivery Device for Angiogenesis” – Biosurfaces, Spring 2002.
- “Electrophoretic Separations of DNA in Microfluidic Systems” - Molecular Separations, Fall 2001.

LEADERSHIP EXPERIENCE

Founder, Center for Biotechnology and Interdisciplinary Studies (CBIS) Graduate Student Association Rensselaer Polytechnic Institute **(Spring 2006)**

- Formed the graduate student association at the newly formed CBIS at RPI to promote interaction among students from varied backgrounds.

Founder and Organizer, CBIS Student Seminar Series Rensselaer Polytechnic Institute **(Summer 2005-Summer 2006)**

- Conceptualized and started a seminar series at the newly formed CBIS at RPI to increase interaction among researchers across departments. The idea received excellent response and has been a huge success.

Secretary, Rensselaer Biotechnology Student Association **(Fall 2003-Spring 2004)** Rensselaer Polytechnic Institute

- Worked on a team to organize company visits, seminars, and specific events to foster interaction between industry and students interested in Biotechnology at RPI.

Vice-President, Graduate Student Association (GSA) **(Fall 2002-Spring 2003)** Rensselaer Polytechnic Institute, Department of Chemical and Biological Engineering

- Organized various events to promote greater interaction among graduate students in the department.

General Secretary, Indian Institute of Chemical Engineers (IChE) Student Chapter **(1999-2000)** D. J. Sanghvi College of Engineering, Mumbai (India)

- Led a team of 20 to organize various plant visits and other intra-college inter-departmental events.
- Collaborated with IChE Student Chapters from other institutes to organize inter-collegiate functions that involved 6 institutions and up to 500 students.