

Vijayasekaran Boovaragavan, Ph.D.

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Postdoctoral Assistant
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Research Interests

I am interested in studying electrochemical systems using mathematical techniques. My research concentrates on developing electrochemical models, simulation techniques and dynamic optimization routines for studying batteries, fuel cells, electro-organic synthesis, electro-plating and corrosion. I follow both analytical and numerical approaches as well as semi-analytical methods and numeric-symbolic solutions. I am interested in dynamic optimization methods like control vector iteration and iterative dynamic programming. All of my simulations are performed in Maple, Matlab or Fortran environment.

Education

Ph.D., Chemical and Electrochemical Engineering,
Central Electrochemical Research Institute, India, 2005 – *Dissertation on* Contribution to dynamic optimization and modeling in electrochemical systems (Advisor: Dr. C. Ahmed Basha)
M.S., Chemical Engineering,
Annamalai University, India, 2002 – *Thesis on* Kinetic studies on solid-solid reactions
B.S., Chemical Engineering,
Annamalai University, India, 2000

Awards/Honors/Fellowships

- *Young Authors' Award of the International Society of Electrochemistry* for the paper, "Evaluation and improvement of dynamic optimality in electrochemical reactors" (in *Electrochimica Acta*) 2006
- *Postdoctoral Research Fellowship of the Center for Energy Systems Research,* Tennessee Technological University, Tennessee, United States, 2006
- *Young Scientist Award of the Central Electrochemical Research Institute,* India for both the years 2004 and 2003
- *National Research Fellowship of the Council of Scientific and Industrial Research,* India, 2002 to 2005 (5-year Ph.D stipend)
- *First Class with Distinction Degree* for both M.S. ChE., (2002) and B.S. ChE., (2000) *Annamalai University,* India

Professional Expertise

- Novel electrochemical models for the exact and rapid simulation of electrochemical processes that govern the performance of electrochemical power sources and other electrochemical systems.
- Dynamic optimization techniques for the evaluation of precise optimal time-varying control strategy for electrochemical processes to achieve effective control
- Mathematical simulation of AC impedance response of batteries/fuel cells using a novel numeric symbolic solution method and parameter estimation
- Efficient electrochemical model simplification technique using an innovative effort of simultaneous polynomial approximation and variable averaging approach for rapid and exact simulation
- Research proposals, articles and report preparation for various funding agencies/scientific journals
- Laboratory techniques: Simple electrochemical experiments
- Simulation software: Maple, MATLAB (ODEs solvers), Visual Fortran (DAEs solver DASSL), C, C++, MS-Office, MS-Visio

Professional Experiences

Postdoctoral assistant – January 2006 to Current

Center for Energy Systems Research, Tennessee Technological University
Cookeville, Tennessee 38505, United States. <http://www.tntech.edu/>

- Efficient modeling of Li-ion batteries and real-time simulation of charge/discharge processes for emerging applications like on-board monitoring, on-line optimization, hybrid environments, etc
- Multi-scale simulation of electrochemical devices using prudent/efficient approximation techniques, simultaneous polynomial approximation and volume averaging approach
- Numeric symbolic solution for simulating AC impedance response of the batteries/fuel cell as a function of all the system parameters, closed-form in system parameters and numerical in space
- Optimal time-varying charge/discharge profile for rapid charging/maximum utilization factor
- Parameter estimation using Gauss-Newton method
- Assist in writing research proposals

Working for the completion of following two research projects,

- *Efficient modeling and simulation of Li-ion batteries for satellite applications in an automated environment*, National Reconnaissance Office – Director’s Innovation Initiative, \$400,000. NRO-000-06-C-0093, collaborator - University of South Carolina, Columbia, South Carolina.
- *Exploratory research – A novel AC impedance model for understanding transport and kinetic limitations of electrochemical devices*, National Science Foundation, \$30,000. CTS 0609914

Research scholar – October 2002 to December 2005

Central Electrochemical Research Institute (CECRI)

Karaikudi, Tamilnadu 630006, India. <http://www.cecri.res.in/>

Research and Development:

- Modeling, simulation and dynamic optimization of electrochemical reactors using control vector iteration or iterative dynamic programming for electro-organic processes
- Novel, simple and efficient shrinking-core discharge model for simulating discharge behavior of lead-acid batteries based on the principles of chemical reaction engineering
- Development of electrochemical expert system toolbox for corrosion science and engineering
- New semi-analytical method for evaluating current density distribution in electrochemical systems
- Wrote several research articles and assisted in writing research proposals

Teaching: Taught following courses for B.S (Chemical and Electrochemical Engineering) and M.S (Electrochemical Engineering) programs conducted by Anna University at CECRI, India. Undergraduate courses: Chemical reaction engineering, electrochemical reaction engineering, applied mathematics in chemical engineering. Graduate course: Electrochemical engineering

Scientific Publications/Presentations/Book chapters

1. V. R. Subramanian, Vijayasekaran Boovaragavan, K. Potukuchi, V. D. Diwakar and A. Guduru. “A novel numeric symbolic solution for impedance response of electrochemical devices – 1. Introduction of the method,” *Electrochemical and Solid-State Letters*, accepted for publication, 2006.
2. Vijayasekaran Boovaragavan and C. Ahmed Basha. “A novel approach for computing tertiary current distributions based on simplifying assumptions,” *Journal of Applied Electrochemistry*, 36(7), 745-757, 2006.
3. Vijayasekaran Boovaragavan and C. Ahmed Basha. “Shrinking core discharge model for the negative electrode of a lead-acid battery,” *Journal of Power Sources*, 158(1), 710-721, 2006.
4. Vijayasekaran Boovaragavan and C. Ahmed Basha, “Dynamic optimization of electrochemical reactors for the exact optimal control of consecutive electrochemical reactions,” *Chemical Engineering Journal*, 117(3), 213-221, 2006.
5. Vijayasekaran Boovaragavan and C. Ahmed Basha. “Evaluation and improvement of dynamic optimality in electrochemical reactors,” *Electrochimica Acta*, 51(2), 200-207, 2005. (*awarded article - Young Authors’ Prize of the International Society of Electrochemistry*)

6. Vijayasekaran Boovaragavan and C. Ahmed Basha. "Modeling in electrochemical engineering – a critical review," *Transactions of the SAEST*, 40(1) 1-13, 2005.
7. Vijayasekaran Boovaragavan, C. Ahmed Basha and N. Balasubramanian. "Optimization of electrochemical reactors using genetic algorithms," *Chemical and Biochemical Engineering Quarterly*, 18(4), 359-366, 2004.
8. Vijayasekaran Boovaragavan and C. Ahmed Basha. "Expert system toolbox for corrosion problems," *Bulletin of Electrochemistry*, 20(3), 133-138, 2004.

Presentations (* denotes presenter)

9. Venkat Subramanian*, Vinten Diwakar and Vijayasekaran Boovaragavan. "System level component models for electrochemical power sources in hybrid environments," Annual Meeting of AIChE, San Francisco, California, November 12-17, 2006. (*Oral Presentation*)
10. Vijayasekaran Boovaragavan, V. D. Diwakar, K. Potukuchi and V. R. Subramanian*. "Optimization of operating conditions for electrochemical power sources," *209th Electrochemical Society Meeting*, Colorado, May 7-11, 2006. (*Oral Presentation*)
11. Vijayasekaran Boovaragavan, V. R. Subramanian* and C. Ahmed Basha. "Batch electrochemical reactor dynamics and optimal control of electro-dimerization of acrylonitrile," *209th Electrochemical Society Meeting*, Colorado, May 7-11, 2006. (*Oral Presentation*)
12. Vijayasekaran Boovaragavan. "Dynamic optimization of batch reactors for electro-organic synthesis," *Research Seminar Series*, Department of Chemical Engineering, Tennessee Technological University, Tennessee, February 23, 2006. (*Invited Presentation*)
13. Vijayasekaran Boovaragavan* and C. Ahmed Basha. "Calculus of variations based optimal control strategy for electrochemical reactors," *National Symposium on Electrochemical Science and Technology*, Bangalore, India, 22-23 July 2005. (*Oral Presentation*)
14. Vijayasekaran Boovaragavan. "Modeling, simulation and optimization of electrochemical reactors," *Research Promotion Program*, Department of Chemical Engineering, Thirumalai Engineering College, Kancheepuram, India, March 10, 2005. (*Invited Presentation*)
15. Vijayasekaran Boovaragavan* and C. Ahmed Basha. "Computation of current density distribution in moving electrode process," *Indian Chemical Engineering Congress*, Mumbai, India, December 27-30, 2004. (*Poster presentation*)
16. Vijayasekaran Boovaragavan* and C. Ahmed Basha. "Modeling of lead-acid battery discharge," *International Conference on Electrochemical Power Systems*, Hyderabad, India, 20-21 December 2004. (*Poster presentation*)
17. Vijayasekaran Boovaragavan. "GAs for electrochemical engineering optimization," *Faculty Training Program*, Department of Chemical Engineering, Coimbatore Institute of Technology, Coimbatore, India May 14-27, 2004. (*Invited Presentation*)
18. Vijayasekaran Boovaragavan* and C. Ahmed Basha. "Optimization of industrial batch electrochemical reactors using GAs," *Eleventh National Convention of Electrochemists*, Tiruchirapali, India, December 26-27, 2003. (*Oral Presentation*)
19. Vijayasekaran Boovaragavan* and C. Ahmed Basha. "Development of expert system for corrosion problems," *Eleventh National Conference on Corrosion Control*, Vadodara, India, July 17-19, 2003. (*Oral Presentation*)

Book chapters

20. Vijayasekaran Boovaragavan and C. Ahmed Basha, "Electrochemical systems – static and dynamic optimization" in Satoshi Kaneco (Editor), "Photo/Electrochemistry & Photobiology in the Environment, Energy and Fuel," Research Signpost, India, (Under preparation) 2007.

Professional Associations

- The Electrochemical Society <http://www.electrochem.org/>
- Indian Institute of Chemical Engineers <http://www.iiche.org.in/>
- Society for the Advancement of Electrochemical Science & Technology <http://www.saest.com/>