Course: Fabrication Technology for MEMS and NEMS

Jeffrey T. Borenstein
Director
Biomedical Engineering Center
Draper Laboratory
555 Technology Square, Cambridge, MA
Tel: 617-258-1218

email: jborenstein@draper.com

Abstract

This short course will cover the fundamentals of fabrication tools and processes used to produce MEMS and NEMS structures and devices. The course will begin with an overview of microsystems technology, starting with the development of the earliest MEMS devices for inertial guidance and navigation and pressure sensing. We will then cover MEMS sensors for acoustic and optical measurements, and then move into biological and chemical microsystems. Many of these devices have already been commercialized, with applications in the automotive, military, aerospace, consumer electronics and medical device markets. MEMS-based actuator technologies such as micropumps, micromirrors, ink-jet printer heads and micromotors will also be briefly described. Finally we will address the emergence of NanoElectroMechanical Systems in these and other applications and markets.

Following this overview, the course will then focus on the microfabrication and nanofabrication technologies used to build these sensors and systems. The basic processes used to build MEMS devices will be covered in a module format. Processes of interest include photolithographic processes, polysilicon and other thin film deposition techniques, Deep Reactive Ion Etching (DRIE), and wafer bonding, and specialized tools used for these processes will be described. Novel MEMS and NEMS fabrication tools developed in the last several years will then be discussed, including laser micromachining, replica molding and three-dimensional microstructuring techniques. We will conclude with a discussion about the key areas for micro- and nanofabrication technology development over the next 5 years required for advancement in both the research and manufacturing arenas.

Biography

Jeffrey Borenstein is currently a Distinguished Member of the Technical Staff at the Charles Stark Draper Laboratory in Cambridge, Massachusetts. He is also Program Leader for Biomaterials and Tissue Engineering for the Center for Integration of Medicine and Innovative Technology (CIMIT). Dr. Borenstein is a Principal Investigator for several programs in tissue engineering and drug delivery with support from the NIH, NSF and other sources. Dr. Borenstein has a Ph.D. in Physics from the University at Albany and 25 years of experience in microelectronics, microfabrication technology and biomedical devices. Dr. Borenstein's research is focused on the application of microfabrication technology and microfluidics for tissue engineering, cell-based in vitro systems for discovery, and implantable drug delivery systems. He has thirteen issued patents, as well as twenty published patent applications and over eighty peer-reviewed journal articles and conference proceedings.