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Timothy J. Harpster, Ph.D.

Objective

My dissertation work encompassed a study and implementation of micropackaging for harsh environment applications, which culminated in the completion of a hermetically bonded wafer-level micropackage for use with a fully implantable cochlear prosthesis. Through this work I developed an expertise related to: design and fabrication of MEMS sensors and wafer-level packages; understanding properties of materials related to wafer fabricated devices and wafer bonding; and long-term reliability testing. Additionally, the completion of an application ready prototype package required collaborating with researchers from other disciplines to set design rules and specifications. I seek to obtain a position where I can continue to use my thirst for the application of the sciences and further develop skills to reach targeted goals where leadership, team participation, and individual efforts are needed and recognized.

Education

University of Michigan Ann Arbor, MI
Ph.D. in Electrical Engineering Fall 2005
Dissertation: *Hermetic Packaging and Bonding Technologies for Implantable Microsystems*
Thesis Advisor: *Professor Khalil Najafi*

University of Michigan Ann Arbor, MI
M.S. in Electrical Engineering May 2000
Major/Minor: *Solid State Devices/Circuits & Microsystems*
Related Coursework:

- Solid State Devices Laboratory
- Properties of Transistors
- Monolithic Amplifier Circuits
- Integrated Sensing Systems
- Analog Integrated Circuits
- Biomedical Instrumentation and Devices
- Semiconductor Optoelectronic Devices
- Microelectronics Process Technology
- Digital Integrated Circuits
- Applied Quantum Mechanics

University of Dayton Dayton, OH
B.S. in Electrical Engineering, magna cum laude May 1998
Minor: Physics (Summer classes at Ohio State University)

Experience

Center for Wireless Integrated MicroSystems (WIMS) – www.wimserc.org Ann Arbor, MI
Ph.D. Research September 2000-present

- Dissertation Summary – The main objective was to develop a wafer-level hermetically-sealed package for a variety of MEMS devices, and especially for long-term use in bioimplantable microsystems. The research: 1) developed two passive wireless humidity sensors; 2) produced long-term hermeticity and corrosion test results on glass-Si bonded micropackages; 3) demonstrated long-term hermeticity and biocompatibility tests in biological hosts, and 4) developed a novel low-temperature glass-to-Si wafer-level package technology.
- Microfabrication – Gained working knowledge of many microfabrication and materials characterization processes including: photolithography, plasma etching, wet etching, electroplating, thin-film deposition, thin-film growth, wafer bonding, surface metrology, thin film metrology, and electron beam microscopy. Subsequently served as a mentor to others on many of these processes.
- Sensors – Designed, fabricated and implemented two novel passive wireless humidity sensors, Pirani pressure sensors, and platinum RTD's for the testing and development of hermetically sealed micropackages.

- Material bonding – Conducted detailed studies on anodic bonding principles as well as the material properties of solders and eutectics. Used knowledge gained from these studies to fabricate hermetically sealed anodically bonded packages as well as develop, publish, and patent a novel low-temperature wafer-level bonding technique using a glass-to-Au-Si eutectic anodic bond.
- Numerical Analysis – Employed numerical analysis to optimize the wireless range of passive wireless humidity sensors by modeling magnetically coupled antennae, optimize wafer bonding contact pressure by modeling solder dynamics, and predict encapsulated pressure in sealed microcavities by calculating impurity outgassing from Pyrex glass.
- System design and implementation – Designed and fabricated a biocompatible, low-temperature wafer-level bonded package for use in implantable microsystems. Also, this package was assembled as part of a fully implantable cochlear prosthesis prototype. The design of the implantable micropackage required collaborating with researchers in other disciplines (material science, physics, biomedical, electrical, and mechanical engineering) to set design rules and application specifications.
- Test equipment design and construction – Specified, procured, calibrated and operated equipment for wireless sensor testing, temperature calibration of commercial wafer bonder tools, and automated multiplexed testing of microfabricated pressure, temperature and humidity sensors. Gained experience with pressure, temperature and humidity measurement and calibration.
- Biocompatibility testing – Conducted extensive long-term in-vitro and in-vivo testing of glass-Si bonded micropackages. In-vitro studies included room and high temperature saline soak tests as control and accelerated condition experiments for determining package lifetimes and corrosion resistance of package materials. In-vivo studies included monitoring integrity of implanted micropackages and evaluating multiple implant environments. Also, analysis of explanted tissues was conducted for determining host-responses to glass-Si micropackages.

Engineering Apprentice, Intek Inc. Westerville, OH
Summer/Winter Internship 1996-1997, 1998-2000

- Conducted a detailed circuit analysis using Laplace transforms and PSpice to determine the impact of the combined power source and input filter impedance as a function of frequency on a DC/DC power converter stability used in a flow meter for the Active Thermal Control System of Space Station. Annotated ORCAD drawings to simplify interpretation of schematics. Soldered and tested circuit boards; inspected circuit boards for solder joint integrity.
- Assisted in the development of Labview software for the RheoVac™ Diagnostic System, a real-time air in-leak measurement system for power plant condensers.

Design of PLL's Using Digital Programmable Logic Devices Ann Arbor, MI
Summer Research Student June-August, 1997

- Conducted research focused on developing a library of digital code for realizing common communication based circuit function. Multiple designs for achieving the digital equivalent of a phase locked loop circuit were created and evaluated using Altera software development tools.

ACADEMIC PROJECTS

- Worked with a team of students to evaluate the potential of next generation semiconductor equipment for producing 25 nm gate length transistors. Winter 1999

- Designed and used HSPICE to simulate a CMOS operational amplifier. Special attention was focused to optimize slew rate, phase margin, and CMR to meet challenging design specifications. Fall 2000
- Worked with a team of students to design and simulate (using HSPICE) two voltage controlled oscillator designs targeted to satisfy DCS-1800 telecommunications standards using standard high-volume low-cost CMOS processes. The first VCO design used a fully differential ring oscillator topology and the second VCO design used a cross-coupled (or "negative-gm") LC-VCO. Winter 2001

PUBLICATIONS

- **T. J. Harpster**, S. Hauvespre, M. Dokmeci, B. Stark, A. Vosoughi, and K. Najafi. "A Passive Humidity Monitoring System For In-Situ Remote Wireless Testing Of Micropackages", *IEEE MEMS 2000*, Miyazaki, Japan, pp 335-340, January 23–27 2000.
- O. Akar, T. Akin, **T. J. Harpster**, and K. Najafi, "A Wireless Batch Sealed Absolute Capacitive Pressure Sensor," *The 14th European Conf. on Solid-State Transducers (Eurosensors XIV)*, Copenhagen, Denmark, pp. 585-588, August 27-30, 2000.
- **T. J. Harpster**, B. Stark, and K. Najafi. "A Passive Wireless Integrated Humidity Sensor", *IEEE MEMS 2001*, Interlaken, Switzerland, pp 553-557, January 2001.
- B. Stark, M. Dokmeci, **T. J. Harpster**, and K. Najafi, "Improving Corrosion-Resistance of Silicon-Glass Micropackages Using Boron Doping and/or Self-Induced Galvanic Bias" *39th Annual International Reliability Physics Symposium*, Orlando, FL, pp. 112-119, May 2001.
- **T. J. Harpster**, and K. Najafi, "Long-term testing of hermetic anodically bonded glass-silicon packages," *IEEE MEMS 2002*, Las Vegas, NV, pp. 423-426, January 2002.
- **T. J. Harpster**, B. Stark, and K. Najafi, "A passive wireless integrated humidity sensor," *Sensors and Actuators A: Physical*, vol. 95, is. 2-3, pp. 100-107, January 2002.
- **T. J. Harpster**, S. Hauvespre, M. Dokmeci, and K. Najafi, "A Passive Humidity Monitoring System for In-Situ Remote Wireless Testing of Micropackages," *Journal of Microelectromechanical Systems (JMEMS)*, vol. 11, no. 1, pp. 61-67, February 2002.
- **T. J. Harpster**, K. Najafi, "Field-assisted bonding of glass to Si-Au eutectic solder for packaging applications" *IEEE MEMS* 2003, Kyoto, Japan, pp. 630-633, January 2003.
- **T. J. Harpster**, S. Nikles, M. Dokmeci, and K. Najafi, "Long-term hermeticity and biological performance of anodically-bonded glass-silicon implantable packages" *IEEE Transactions on Device and Material Reliability*, vol. 5, no. 3, September 2005.

PATENT

U.S. Patent No. 6939778B2, **Timothy J. Harpster**, Khalil Najafi, "Method of Joining an Insulator to a Substrate." Sept. 6, 2005.

COMPUTER SKILLS

Environments: Windows, limited UNIX, limited Macintosh
Applications: Labview, ICstation, HSPICE, MATLAB, 3D Studio Max, PSpice, ORCAD, AutoCAD.

LEADERSHIP ROLES

Social Chairman of WIMS Student Leadership Council	2001
Vice President of WIMS Student Leadership Council	2002
President of WIMS Student Leadership Council	2003
Mentor for the Detroit Area Pre-College Engineering Program	2003-2004

HONORS

NAECON scholarship – University of Dayton
Presidential scholarship – University of Dayton
Golden Key National Honor Society
Recipient of the 2003 WIMS Outstanding Student Leadership Award

CITIZENSHIP

United States

REFERENCES

Available upon request