Draper Rad-Hard MicroElectronics Research Interests

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Introduction

The development and characterization of radiation-hardened and high reliability electronics is a key enabler for Draper's efforts to support the nation's strategic and space systems. Our research interests include development of novel technologies, novel approaches to radiation-sensitive system elements, and characterization of state-of-the-art technologies for high reliability radiation environments.

About Draper Laboratory (www.draper.com)

Draper is an independent, not-for-profit corporation, chartered to work on problems in the national interest. Draper is seeking collaborative research partners from universities to further the state of the art in key technologies of mutual interest. Research Whitepapers describing Draper's technology interests and Technical Points of Contact can be found on the Draper Scholars webpage (Draper Scholar Program | Draper). The Draper Scholars Program funds thesis-bearing MS and PhD students at partner universities as one of the effective ways to progress the technology. Other means of collaborative research (e.g. joint proposals, sabbaticals, etc.) are also encouraged. Please contact education@draper.com if you have further questions.

Research Interests

1. ***Demonstration of novel transistor technologies***

   While improvements to processes and materials offer the possibility of incremental improvement in the radiation hardness of semiconductor devices, demonstration of vacuum microelectronic systems would represent a step-change in hardness. Draper would like to pursue demonstration of this technology and associated processes, such as:

   a. Proof-of-concept of a vacuum-insulated transistor-like devices at useful voltages
   b. Development of wafer-level packaging techniques compatible with high- or ultra-high-vacuum inside the package

2. ***Wafer-scale integration and packaging challenges***

   Many commercial technologies and processes either have not been evaluated for the Draper mission space or have been shown not to meet the needs of some Draper applications. Characterization of these existing devices or development of novel processes to address these challenges would be extremely interesting. Some example research areas are:

   c. Evaluation of long-life, high-reliability uses of the commercial devices, such as long-term drift in consumer inertial sensors or stress relaxation in wafer-scale bonds
   d. Heterogenous integration of different processes or technologies, with a focus on leveraging different rad-hard technologies into a single device with multiple capabilities
   e. Development and characterization of wafer-scale bonding techniques that are compatible with the long-term operation of stress-sensitive MEMS components.
   f. New concepts for MEMS sensor auto-calibration

g. Study of anelastic and inelastic behavior in MEMs materials, including dielectric and metal layers

3. Characterization of state-of-the-art technologies

New processes and technology nodes, such as the 12LP process from GlobalFoundries, show promise for producing radiation-hardened devices. Systems that require rad-hard technologies typically also require high reliability performance. These new processes need to be characterized for both reliability and radiation hardness in a variety of environments. Similarly existing high-reliability processes (e.g., automotive devices) should be evaluated for radiation hardness in the natural space environment (NSE).

Example areas might include:

a. Experimental characterization of devices made on various SOTA technology nodes
b. Evaluation of neutron single event effects (nSEE) for different nodes and processes
c. NSE evaluation of high-reliability components and sensors. For example, automotive parts for use in space.

4. *Novel approaches to sensitive components*

Certain components required in a system are more sensitive to radiation than others. These devices are critical to the operation of the system and often require significant compromises in system design to accommodate them. Development of novel approaches that are transformative changes in the state-of-the-art would enable a variety of new applications and approaches to Draper's key challenges. Critical devices that are of interest include power conversion technology, non-volatile memory, and precision voltage and timing references.

We would be targeting PhD students for the development of novel technologies and studying complex phenomena. We would be targeting MS students for the characterization of existing technology and application to specific problems of interest to Draper.