An Investigation into the Economic Design and Use of Pulsed-Lasers to Simulate the Effects of Heavy-Ion Bombardment on Radiation-Hardened Microelectronics

SLU SCALE Project
Concept Design Phase
Spring 2022

SAINT LOUIS UNIVERSITY
PARKS COLLEGE OF ENGINEERING, AVIATION AND TECHNOLOGY

Problem Statement

"Develop an alternative to Heavy Ion testing, that allows for basic radiation-hardened product verification, while remaining accessible, in terms of both cost and time, to academic and commercial consumers."

Concerning Extent Radiation Testing Techniques

Heavy Ion Testing:

- Fiscally Expensive
- Energy Intensive
- Long Wait Times

Summary of Approach

1. Introductory Explanation and Topic Orientation
2. Division of Project Team into Sub-Groups
3. Literature Review Process
4. SME Interviews
5. Improved Definition of Problem Statement and Customer Needs
6. Proposal Creation
7. Proposal Refinement and Editing

Stakeholders and Needs

Potential Customers:

- Commercial Entities
- Academic Institutions
- Hobbyists
- Defense Contractors
- Government Research Agencies

Needs:

- Inexpensive
- Easy to Use
- Reliable with Little Error
- Make Small, Accurate Measurements

Project Scope

Alternative to heavy-ion radiation testing:

- Cost-efficient construction (commercial-off-the-shelf)
- Readily deployable in most commercial and academic research environments
- Minimal maintenance, operation, and personnel training costs
- Scalable cubic test volume; easily modified

Technical Requirements

- Shall require minimal laser safety equipment and protocols.
- Shall integrate with common laboratory infrastructure.
- Shall accommodate most microelectronic specimen.
  (e.g., de-capped ICs, photoelectric diodes, etc.)
- Shall produce a fixed wavelength beam capable of causing SEEs.
- Should interface with most common data acquisition software suites.
  (e.g., LabView)

Lasers and Physics

• Substrate(s):	Silicon-based semi-conductors
• Laser type:	Q-switched pulsed laser
• Target Wavelength(s):	650 to 800 nm (fixed)
• Duration of Exposure:	5 to 300 ps
• Pulse Energy Range:	5 to 40 nJ
• Beam Aperture:	0.5 to 1.5 μm
• Target Depth of Saturation:	10 to 300 μm
• Target Band-Gap Range: (*simulated*)	1.0 to 1.5 eV

Mechanics, Apparatus, Structure

Needs to be considered

- Test area size
- Method of adjustment
- Range of adjustment
- Configurable laser beam

Current ideas

- Volume of 1 cubic foot
- Moveable plate
- 30-100 mm in X and Y axes
- Various lens sizes

Software and User Interface Environment

What should it do?

- Easy to learn UI to control necessary variables.
- Interface with data collection software (LabView).
- Synchronization with external testing device.

What does it look like?

- Digital interface to input testing specifications
- Preset vs Customized testing procedure

Safety Protocols (Environment and Procedure)

Safety considerations:

- Wavelength of the laser
- Average accidental exposure time
- Maximum irradiance of the laser

Solutions:

- Operational curtain to shield any reflection of the laser during testing.
- Wavelength specific safety glasses (~700 nm)

Proposal

2022-2023 School Year

- Fall:
  - Develop design which can be used to create a working prototype
  - Research acquisition of materials.
- Spring:
  - Continue design and finalize initial design

2023-2024 School Year

- Fall:
  - Begin construction of prototype
- Spring:
  - Continue construction of prototype
  - Begin testing for prototype

Conclusion

Questions?