Analysis of the Single-Event Latch-up Cross Section of a 16nm FinFET System-on-Chip using Backside Single-Photon Absorption Laser Testing and Correlation with Heavy Ion Data

M. Fongral\(^1\), V. Pouget\(^1\), F. Saigne\(^1\), M. Ruffenach\(^2\), J. Carron\(^2\), F. Malou\(^2\), J. Mekki\(^2\)

1 IES, Université de Montpellier, CNRS, Montpellier, France
2 CNES, Toulouse, France

matthieu.fongral@umontpellier.fr

1 CNES, Toulouse, France
2 IES, Université de Montpellier, CNRS, Montpellier, France

Abstract

The SEL cross section of a 16nm finFET System on Chip (SoC) is investigated by combining Single Photon Absorption (SPA) laser testing, emission microscopy and embedded instrumentation. Results indicate the origin of latch-ups and present excellent correlation with heavy ion data.

Introduction

- Single-event latch-up: a major concern in FinFET technologies, observed in 16nm [1, 3, 4] and 7nm devices [2]
- SPA laser testing: an interesting complementary technique to spatially locate the origin of SEL events within a device
- Localization of SEL sensitivity in a 16nm FinFET complex SoC?

Device under test:
- Xilinx Zynq Ultrascale+ (XCZU3EG)
- Technology: TSMC 16nm bulk FinFET

Laser tests:
- SPA laser system @ IES
  - Wavelength: 1064nm
  - Pulse duration: 30ps
  - Spot size: 1.1µm

SEL sensitive regions overview

- SEL mappings performed on the different sensitive regions to extract:
  - Laser energy threshold
  - SEL sensitive area as a function of the laser energy
- Most of SEL-sensitive areas are located in the Programmable Logic (PL)

Examples of SEL laser mappings

- Zones A, B and C repeated over the full width of the chip
- EMMI images associated to SEL triggering confirm the latch-up nature of the events

Correlation & Discussion

- Good correlation between laser and heavy ion data
- Both for the threshold LET and the saturation cross section

No significant contribution to the SEL cross section missed during our tests
No SEL triggered in the core-logic of both the PS and the PL
- SEL in this SoC probably only occurs in mixed-signal and IO circuits connected to the 1.8V or 1.2V supplies

Conclusion

- Analysis of the SEL cross section of a complex programmable SoC
- Simple electrical setup + DUT-embedded instrumentation, SPA laser testing + in-line light emission microscopy
- SEL sensitive areas and functions identified
- Good correlation of laser testing results with heavy ion data
- No SEL is triggered in the core-logic sections of this device
- IOs are the main contributors to the SEL cross section at high LET

References