File: C:\data\eitan\vlsi_tec\TEACHING\{60} Courses and Training and My_Consulting and Legal\{3-Day Seminar} - Reliability of Semiconductors (Technion ACRC)\Course Material\The rule of the game and Sylabus (for the students).doc

Last Saved: Tuesday, August 30, 2022

Dr. Eitan Shauly, winter

For ACRC, Department of Electrical Engineering, Technion, Israel

Teaching Assistance: Efrat Ordan

Lecture time: 18-Sep'22 (Sunday), 19-Sep'22 (Monday), 20-Sep'22 (Tuesday), 9:00AM-18:00PM.

COURSE: MICROELECTRONIC RELIABILITY

COURSE SUMMARY (THE AIM OF THIS COURSE)

In this course, we will discuss systematically the various failure mechanisms that may occur during the manufacturing and use of the semiconductor devices: electromigration, stress-induced voids, Hot-Carrier Injection, Negative Bias-Temperature Instability, oxide wear out (breakdown, Time-Depended-Dielectric-Breakdown (TDDB), and Inter-Metal-Dielectric-TDDB), and others. We also discuss topics such as automotive reliability, ISO26262, wafer foundry qualification, and environmental reliability. The course provides an excellent opportunity to obtain first-level knowledge for individuals who already have some process background but are relatively new to semiconductor reliability.

Course will be in Hebrew, but all slides will be in English.

TOPICS:

1. Introduction to Reliability of Microelectronic Devices
2. Different reliability definitions: MTBF, CumF, different types of distributions,
3. The basic equation for Time-to-Failure under voltage and temperature acceleration conditions,
4. Failures due to Electromigration (EM) in Al and Cu interconnects: mechanisms, modeling, process solutions, device solutions, layout solutions,
5. Stress migration (SM) and Stress Induced Voids (SIV) in Cu interconnects

6. HEI (Hot-Electron-Injection) and Hot Holes Injection in MOSFETs and FinFETs: mechanisms, modeling, process solutions, device solutions, layout solutions,
7. NBTI (Negative Bias Temperature Instability) and P (Positive) BTI: mechanisms, modeling, process solutions, device solutions, layout solutions,
8. Oxide Integrity:
    1. Different oxide failure mechanisms, percolation modeling,
    2. Voltage to breakdown: measurements and analysis
    3. TDDB (Time-Depended-Dielectric-Breakdown) for Gate oxides, measurement and analysis, IBM modeling,
    4. Capacitors reliability, with Oxide-Nitride-Oxide, Nitride, Ta2O5 and other dielectrics: mechanisms, modeling, process solutions, device solutions, layout solutions,
9. Environmental reliability: HTOL (High-Temperature-Operation-Lifetime), ELF (Early failure), DfR (Design-for-Reliability): testing methodology and analysis, examples,
10. Physical and Environmental Qualification plan and results for advanced ICs,
11. Automotive Reliability: DfA (Design-for-Automotive) and ISO26262, Manufacturing and Quality (IATF16949), Reliability (AEC-Q100), Design IPs (Intellectual Properties) for Automotive
12. OVS (Electrical Over Stress), ESD (Electro-Static-discharge) protection, LU (Latchup) protection,
13. Course summary.

INTENDED AUDIENCE AND PRE-REQUISITES:

- 044231 Electron Devices 1 (MOS)

REFERENCES:

1. Reliability and Failure of Electronic Materials and Devices, Milton Ohring, Academic Press (1998)
2. Reliability Physics and Engineering: Time-To-Failure Modeling, J. W. McPherson 2010th Edition

3. Reliability Wearout Mechanisms in Advanced CMOS Technology (IEEE Press Series on Microelectronic Systems, Alvin W. Strong et al., John Wiley (2009)
4. Design Rules in a Semiconductor Foundry, Edited by Eitan N. Shauly, 2022 Jenny Stanford Publishing Pte. Ltd.
5. IRPS (International Reliability Physics Symp) publications and tutorials

The rules of the game:

1. Students which like to get the academic credit, MUST come to close!
2. Please be active in class.
3. Solving problems ("Targilim") is an integral part of this course. These exercises are a must for those who desire to finish.
4. The training team will provide some problem sets. They must be returned directly to Mr. Efrat Ordan, on hard copy (NOT via email nor muddle). 35%
5. The only exception to rule #3 are circumstances such as army duty, sickness, business abroad, and other cases of "force majeure". Please come and see Efrat or me in those cases.
6. The finale grade is based on problem sets (35%) and a Final test (65%).
7. Test: 30-Sep'22 (Friday). 9:00AM-12:00PM

Questions and More details:

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