

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

Department of Electrical Engineering

Fabrication and Measurement of MOS Devices

INTRODUCTION

This experiment will introduce the student to some of the methods used industrially in the development of new semiconductor device technologies. As part of the design of a new device (for instance, a sub-micron MOSFET) an engineer must design a new device fabrication process. This new process is generally tested using simple structures, such as the MOS capacitor. The design engineer will compare simulated device parameters, such as oxide thickness and doping distribution, to measured values. This lab will introduce the student to the standard process simulation software, SUPREM, to a simple device simulator, and to several standard electrical measurement methods used to characterize semiconductor devices.

ASSIGNMENT

The student will be required to use the SUPREM software package to simulate the growth of a MOS gate oxide and the deposition of the gate electrode. The simulation will be compared with a device fabricated with the simulated parameters (growth temperature, ambient atmosphere, wafer orientation) through a series of electrical measurements. Finally, one of these measurements, a differential capacitance versus voltage measurement, will be simulated assuming an ideal device. The student will be required to discuss the differences between the measurement and the simulation in terms of non-idealities presented in the references. Specifically, the student will have to make estimates of the total fixed charge in the oxide, and of the interface state contribution.

REFERENCES

1. References on reserve in the library.
2. Write up on the MOS capacitor in the library.
3. The following textbooks:
 - “Physics of Semiconductor Devices,” S. M. Sze, John Wiley & Sons, New York 1981
 - “Physics of MOS Devices,” E. H. Nicollian and J. Brews, John Wiley and Sons, 1982
 - “Physics and Technology of Semiconductor Devices,” A. S. Grove, John Wiley and Sons New York, 1967
4. Faculty with expertise in MOS technology.

EXPECTED RESULTS (as a minimum)

1. A successful SUPREM simulation of the MOS capacitor, using the correct process parameters.
2. A high-frequency and a quasi-static C-V curve measured for the fabricated device.
3. A list of simulated and extracted device parameters to include:
 - oxide thickness
 - substrate doping density
 - mid-gap voltage
4. A simulated quasi-static C-V curve obtained from the 1-d simulator.
5. A discussion of the difference between the measured and the simulated device parameters including an estimate of the total fixed oxide charge, obtained from the measured and simulated quasi-static C-V curves, and the total interface-state contribution, obtained from the automated electrical measurement package.