Engineering Tripos Part IIB, 4B6: Solid State Devices & Chemical & Biological Sensors, 2017-18

Module Leader

Prof D Chu [1]

Lecturer

Prof D Chu

Timing and Structure

Lent term. 12 lectures (including examples classes). Assessment: 100% exam

Prerequisites

3B5 and 3B6 useful

Aims

The aims of the course are to:

- introduce the student to the theory, and design of MOS Field-Effect Transistors (MOSFETs) and thin film transistors (TFTs), based on both single crystal and thin-film materials.
- introduce examples of applications of MOSFETs and thin film transistors (TFTs) as well as in combination with different functional materials.

Objectives

As specific objectives, by the end of the course students should be able to:

- understand MOSFET theory and standard approximations.
- correlate material properties and conduction mechanisms with the MOSFET electrical characteristics, for single crystal, amorphous and polycrystalline thin film devices (TFTs).
- understand the basic properties of ferroelectric materials and its application for non-volatitle memory devices (FRAMs).
- understand the concept of giant magneto-resistance and related materials structures and its applications including non-volatile memory devices (MRAMs).
- understand the basic operation of chemical and biological sensors based on FETs.

Content

The aim of this module is to introduce the student to the theory, and design of MOS Field-Effect Transistors (MOSFETs) and thin film transistors (TFTs), based on both single crystal and thin-film materials. This will be followed by application examples, including ferroelectric and magnetic random access memories (FRAM and MRAM) in non-volatile memory technologies as well as chemical/biological sensors in sensor technologies. Emphasis will be on both device physics and application technology.

MOS Devices Introduction (3L)

Properties of MOS Capacitors, Capacitance - voltage characteristics; MOSFET structures and operation.

MOS Devices & Thin Film Transistors (3L)

Short channel and hot electron effects; Applications and future trends in miniaturising single crystal devices; Amorphous and polycrystalline silicon.

Non-Volatile Memory Devices (4L)

Ferroelectrics and ferroelectric random access memories; Giant magneto-resistance (GMR) and magnetic random access memories.

Chemical & Biological Sensors (1L)

Solution based chemical sensor and biosensors based on FETs.

References

- Lecture Notes. 4B6 Lecture Notes [2]
- S M Sze;" Physics of Semiconductor", John Wiley,1981, Chapters 7 and 8 (note that there is rather more than covered in the lectures).
- J Singh : Semiconductor Devices", John Wiley 2001
- Article "Thin -Film Transistors", by P Migliorato, in Encylopedia of Physical Science and Technology, (Excluding the mathematical derivations), distributed at the lectures.
- J F Scott: "Ferroelectric Memories", Springer, 2000.

Booklists

Please see the Booklist for Group B Courses [3] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [4].

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