The University Of Sheffield.

Electronic & Electrical Engineering.

EEE6395 COMPOUND SEMICONDUCTOR DEVICE MANUFACTURE

Credits: 30

Course Description including Aims

The unit will cover the theory and practice of the growth of compound semiconductor epitaxial layers, the characterisation of those layers and the design, fabrication and characterization of compound semiconductor devices such as LEDs, laser diodes, photodetectors, solar cells and transistors. Students will gain practical experience in all aspects of the creation of a compound semiconductor electronic device including the safety issues associated with device manufacture. Students will also obtain a broad understanding of the global importance of compound semiconductor technology manufacturing through study and exposure to of a number of leading edge research programmes.
By the end of this module, students will be able to:

1 Demonstrate an understanding of, and the ability to apply, a range of industry standard and leading edge technologies available for compound semiconductor design, manufacture, and characterization;
2 Identify safety hazards in the growth of compound semiconductors and in the fabrication processes that create devices.
3 Demonstrate practical skills in the processes involved in the fabrication of a simple component and in making opto-electronic device measurements
4 Demonstrate an appreciation for the importance of the subject in industrial/commercial environments

Outline Syllabus

Review of basic compound semiconductor theory.

Epitaxial growth techniques (MOVPE, MBE), theory and current issues/trends in epitaxial growth.

Characterisation techniques for epitaxial materials (e.g. C-V, PL mapping, X-ray diffraction).

Device fabrication steps (e.g. lithographic techniques including photolithography and nanolithography and metrology, wet etching, ICP/RIE dry etching, plasma deposition, metallization, cleaving, bonding)

R&D status of Optoelectronic devices such as lasers, photodetectors, solar cells, Electronic devices (e.g. GaN HFETs), Biophotonic applications, Solid state lighting

Microscopy of compound semiconductors (e.g. SEM, TEM)

Practical application of epitaxial growth techniques and materials characterization.

Practical application of device fabrication steps to process devices from materials grown on the course.

Practical application of device characterization techniques to devices fabricated on the course.

Time Allocation
75 contact hours (lectures, lab, seminars and tutorials)

Recommended Previous Courses

This course is only available to students registered for the MSc in Semiconductor Photonics and Electronics

Assessment
Essay (25%), Process document (25%), Lab report (in style of an IEEE letter) on fabrication and characterization of opto-electronic device (25%), presentation (15%), attendance (10%).

Recommended Books

Epitaxy, M. Hermann, Springer
Introduction to Microfabrication, S. Franssila, Wiley
Fundamentals of microfabrication, M. Madou, Boca Raton
Process Technology for Semiconductor Lasers, K. Iga, Springer
More text is advised during the course

Objectives
1 Demonstrate an understanding of, and the ability to apply, a range of industry standard and leading edge technologies available for compound semiconductor design, manufacture, and characterization;
2 Identify safety hazards in the growth of compound semiconductors and in the fabrication processes that create devices.
3 Demonstrate practical skills in the processes involved in the fabrication of a simple component and in making opto-electronic device measurements

UK-SPEC/IET Learning Outcomes

All outcomes are assessed by coursework

Outcome Code	Supporting Statement
SM1p / SM1m	In depth understanding of a wide range of materials, techniques, devices within the field of compound semiconductors from design, application, current research interests and issues, through to practical hands-on growth, fabrication and characterisation of example devices. However, from the list of discipline specific examples the closest match is probably only properties of materials. As above, many hours are attributed to discussing scientific principles of compound semiconductors and their design, manufacture and application. Tested in coursework discussing issues in materials growth for modern devices. Assessed by coursework.

SM3m	Materials engineering, physics, chemistry are all relevant, as are applications in communications systems, solid state lighting, biomedical imaging. Assessed by coursework
SM6m	Process chemistry and device physics applied in device manufacture and characterization/analysis. Assessed by coursework
SM1fl	In depth understanding of a wide range of materials, techniques, devices within the field of compound semiconductors from design, application, current research interests and issues, through to practical hands-on growth, fabrication and characterisation of example devices. However, from the list of discipline specific examples the closest match is probably only properties of materials. As above, many hours are attributed to discussing scientific principles of compound semiconductors and their design, manufacture and application. Tested in coursework discussing issues in materials growth for modern devices. Assessed by coursework.
SM3fl	Process chemistry and device physics applied in device manufacture and characterizationanalysis. Assessed by coursework
EA1m / EA1fl	Practical application of semiconductor device manufacturing processes and principles in device manufacture and characterization. Theme B: semiconductor devices. During manufacture of their devices, students gain understanding of the various processes and apply to their material. Following a test run, students analyse the results of the process and make appropriate changes to process parameters to correct critical dimensions or resolve problems. Assessed by coursework
EA2p / EA2m	Optoelectronic devices and circuits. Analysis of device performance using standard fitting techniques for determination of gain/loss/quantum efficiency/series resistance. Assessed by coursework
EA5m	Practical device characterization methodology applied to emerging novel materials/devices originating from a research programme. Assessed by coursework
EA2fl	Practical device characterization methodology applied to emerging novel materialsdevices originating from a research programme. Assessed by coursework
D2p	Students gain first hand experience of the measures that need to be taken to control the hazards inherent in the epitaxial growth and device fabrication processes. Assessed by coursework.
D6p / D6m	Students prepare a report on characterisation of their devices in the style of a research paper and give a presentation to the class (composed of some members working of different devices) Assessed by coursework.
EP2p / EP2m	Wide range of materials and devices and fabrication processes are covered. Knowledge of characteristics (specialized test and measurement equipment, semiconductor fabrication technology, fibre optic communications equipment) addressed . Assessed by coursework
EP3p / EP3m	Laboratory skills put to the test in practical manufacture of semiconductor device that the student then characterizes and writes process document for the manufacture process flow and characterization report in style of an IEEE letter. Crosses themes B and E. Assessed by coursework
EP8m	Experimental uncertainty in characterization of devices and extraction of important parameters, plus tolerances in fabrication processes (e.g. elements

	of statistical process control). Assessed by coursework
EP9m	Current practice and developments in many aspects of compound semiconductor device applications and their manufacture (growth, fabrication processes etc) are discussed. Assessed by coursework
EP1fl	Wide range of materials and devices and fabrication processes are covered. Knowledge of characteristics (specialized test and measurement equipment, semiconductor fabrication technology, fibre optic communications equipment) addressed . Assessed by coursework
EP2fl	Current practice and developments in many aspects of compound semiconductor device applications and their manufacture (growth, fabrication processes etc) are discussed. Assessed by coursework
ET6m	Students cover practical elements of health and safety including COSSH and the safe use of cleanroom facilities and manufacturing equipment/chemicals/gases. Assessed by coursework
ET6fl	Students cover practical elements of health and safety including COSSH and the safe use of cleanroom facilities and manufacturing equipment chemicals gases. Assessed by coursework