University of the West of Scotland
Module Descriptor

Session: 2022/23

Title of Module: Thin Film Processes & Principles (II, Chemica			
Code: PHYS11012	**SCQF Level: 11** (Scottish Credit and Qualifications Framework)	**Credit Points: 20**	**ECTS: 10** (European Credit Transfer Scheme)
School:	School of Computing, Engineering and Physical Sciences		
Module Co-ordinator:	Des Gibson		

Summary of Module

The module offers advanced study at Level 11 of the Plasma and related chemical vapour deposition processes used in the fabrication of thin films. It is suitable for all Level 11 students with an undergraduate science/engineering related degree, and is a core module for students enrolled on the Masters in Advanced Thin Film Technologies programme at UWS. The module is intended to teach fundamental principles of cold plasma and chemical vapour deposition of thin films, relevant to a broad range of functional and industrial applications. The module will also cover methods for the characterisation of the thin film preparation methods mentioned above to ensure optimum performance of the thin films at the end user stage of their life-cycle.

The module will also include practical demonstration sessions, which will enable students to put into practice the principles covered in the lectures. A part of the practical element of the course will be laboratory based sessions on Plasma enhanced chemical vapour deposition process (PECVD), Optical emission spectroscopy (OES) and Langmuir probe measurements. Appropriate industrial visits will also be arranged.

- A brief outline of the syllabus is given below. Plasma and related thin film synthesis Introduction to gas to solid synthesis and preparation methods, covering thermal evaporation, plasma spray, chemical vapour deposition (CVD), sol gel synthesis and single crystal growth from the melt. Cold plasma based plasma enhanced chemical vapour deposition (PECVD),the hollow cathode effect, the effect of gas flow rates, bias voltages and pulsed plasmas on system performance. Introduction to the ion implantation process, electro-plating methods, molecular beam epitaxy, (MBE) and atomic layer deposition (ALD) and related deposition processes. Spin coating and dip coating (deposition of metal, metal oxide and organic films from solution). Semiconductor microfabrication, VLSI/ULSI techniques and LIGA (i.e. lithography, electroforming and moulding will be treated. Stochastic Models of thin film growth The Edwards-Wilkinson model, Kardar-Parisi-Zhang (KPZ) model and the Random deposition with surface relaxation model. The role of the roughness exponent (a), growth exponent (ß), porosity (?) and stochastic noise on the structural evolution and properties of functional thin films. The role of surface energetics and the evolution of thin film growth modes including the Frank Van der Merwe, Stranski-Krastanov and the Volmer-Weber growth modes will be considered. The industrial applications of these models to functional thin films preparation using experimental and the kinetic Monte Carlo modelling approach will be explored. Cold plasma and thin film growth monitoring. This section will introduce the basics of Ellipsometry and the in-situ monitoring of thin film growth with Ellipsometry. The technique of optical emission spectroscopy for monitoring the reacting species and their states during the deposition of thin films will be introduced. The kinetics of ions and electrons and their energy distributions, will be considered based on theoretical models involving the

Boltzmann transport equation inter-alia and experimental Langmuir probe measurements.

- The Graduate Attributes relevant to this module are given below.
- Academic: Critical thinker; analytical; inquiring; knowledgeable; digitally literate; problem solver; autonomous; incisive; innovative.
- Personal: Effective communicator; influential; motivated
- Professional: Collaborative; research-minded; enterprising; ambitious; driven

Module Delivery Method

Face-To-Face	Blended	Fully Online	HybridC	HybridO	Work-based Learning
	✓	✓			

Face-To-Face
Term used to describe the traditional classroom environment where the students and the lecturer meet synchronously in the same room for the whole provision.
Blended
A mode of delivery of a module or a programme that involves online and face-to-face delivery of learning, teaching and assessment activities, student support and feedback. A programme may be considered "blended" if it includes a combination of face-to-face, online and blended modules. If an online programme has any compulsory face-to-face and campus elements it must be described as blended with clearly articulated delivery information to manage student expectations
Fully Online
Instruction that is solely delivered by web-based or internet-based technologies. This term is used to describe the previously used terms distance learning and e learning.
HybridC
Online with mandatory face-to-face learning on Campus
HybridO
Online with optional face-to-face learning on Campus
Work-based Learning
Learning activities where the main location for the learning experience is in the workplace.

Campus(es) for Module Delivery

The module will **normally** be offered on the following campuses / or by Distance/Online Learning: (Provided viable student numbers permit)

Paisley:	Ayr:	Dumfries:	Lanarkshire:	London:	Distance/Online Learning:	Other:
✓					✓	

Term(s) for Module Delivery

(Provided viable student numbers permit).

Term 1	✓	Term 2		Term 3	

Learning Outcomes: (maximum of 5 statements)
On successful completion of this module the student will be able to: L1. At the end of this module, participants will be able to: L1.A critical understanding of the principles underlying the plasma enhanced chemical vapour deposition processes. L2.A critical understand the basic experimental inputs necessary to implement and control chemical and plasma driven thin film deposition processes. L3. Ability to specify chemical vapour deposition processes in relation to thin film performance requirements and specifications. L4.A critical understanding of use and implementation of plasmas in chemical vapour deposition processes. L5. Operational and production awareness of chemical vapour deposition in relation to process throughput, yield, equipment preventative maintenance.

Employability Skills and Personal Development Planning (PDP) Skills	
SCQF Headings	During completion of this module, there will be an opportunity to achieve core skills in:
Knowledge and Understanding (K and U)	SCQF Level 11. SCQF Level 11. (Critical Understanding) 1. Critical understanding of plasma enhanced chemical vapour deposition thin film processes, principles and concepts 2. Critical understanding of required plasma enhanced chemical vapour deposition thin film processes in relation to required thin film properties 3. Extensive, detailed and critical knowledge and understanding of the implementation and required equipment/ control of plasma enhanced chemical vapour deposition thin film processes 4. Critical awareness of operational/ production issues associated with plasma enhanced chemical vapour deposition thin film processes 5. Ability to define the required plasma enhanced chemical vapour deposition thin film processes in relation to end user applications.
Practice: Applied Knowledge and Understanding	SCQF Level 7. SCQF Level 11.(Use of a range of skills) 1.A critical understanding of core plasma enhanced chemical vapour deposition thin film processes, principles, methodologies and techniques as applied to different application/ product-based industries 2. Apply critical analysis to understanding and adopting best practice in plasma enhanced chemical vapour deposition thin film processing for effective ultimate use 3. Execute the plasma enhanced chemical vapour deposition thin film processes to deliver maximum value for end user cost effective research, development and/ or production 4. Develop and implement a mind-set of continuous improvement in relation to plasma enhanced chemical vapour deposition thin film processing.
Generic Cognitive skills	SCQF Level 7. SCQF Level 11.(Apply critical analysis) 1. Apply critical analysis, evaluation and synthesis to issues which are at the forefront of, or informed by, developments at the forefront of plasma enhanced thin film deposition processes, hardware and

	control. 2. Identify, conceptualise and define new and abstract problems and issues related to the inherent difficulty of the plasma enhanced chemical vapour deposition processes. 3. Critically review, consolidate and extend knowledge, skills practices and thinking in plasma enhanced chemical vapour deposition process. 4. Understand the complex multi-parametric nature of the chemical vapour deposition thin film processes, hardware and control and professionally implement best practice research and/ or design of experiments for cost effective implementation	
Communication, ICT and Numeracy Skills	SCQF Level 7. SCQF Level 11.(effective communication skills) 1. Communicate effectively with peers, more senior colleagues and specialists. 2. Use a range of thin film design, project management, design of experimental software to support and enhance cost effective implementation and effectiveness of plasma enhanced chemical vapour deposition thin film processes 3. Undertake critical evaluations of the plasma enhanced chemical vapour deposition of thin film related numerical and graphical data for the purpose of enhancing process efficiency and effectiveness.	
Autonomy, Accountability and Working with others	SCQF Level 7. SCQF Level 11(Taking responsibility for own work and or significant responsibility for the work of others.) 1. Exercise substantial autonomy and initiative in professional and equivalent activities 2. Take responsibility for own work (i.e. independent learner) 3. Take responsibility for a significant range of resources beyond minimum requirements 4. Demonstrate leadership and/or initiative and make an identifiable contribution to change and development (i.e. flipped classroom environment) 5. Practise in ways which draw on critical reflection on own	
Pre-requisites:	Before undertaking this module the student should have undertaken the following:	
	Module Code:	**Module Title:**
	Other:	
Co-requisites	**Module Code:**	**Module Title:**

* Indicates that module descriptor is not published.

Learning and Teaching	
Learning Activities During completion of this module, the learning activities	**Student Learning Hours** (Normally totalling 200 hours): (Note: Learning hours include both

undertaken to achieve the module learning outcomes are stated below:	contact hours and hours spent on other learning activities)
Lecture/Core Content Delivery	20
Tutorial/Synchronous Support Activity	10
Laboratory/Practical Demonstration/Workshop	6
Independent Study	164
	200 Hours Total

****Indicative Resources: (eg. Core text, journals, internet access)**
The following materials form essential underpinning for the module content and ultimately for the learning outcomes: Essential reading 1) M.A. Lieberman and Alan J. Lichtenburg, Principles of Plasma discharges and Materials processing, Wiley, 2005 2) Milton Ohring, Materials Science of thin films 3) F.F. Chen, Introduction to Plasma Physics Recommended reading Supplementary reading
(**N.B. Although reading lists should include current publications, students are advised (particularly for material marked with an asterisk*) to wait until the start of session for confirmation of the most up-to-date material)
Engagement Requirements
Students are academically engaged if they are regularly engaged with timetabled on-campus and online teaching sessions, asynchronous online learning activities, course-related learning resources, and complete assessments and submit these on time. Please refer to the Academic Engagement and Attendance Procedure at the following link: Academic Engagement and Attendance Procedure

Supplemental Information

Programme Board	Physical Sciences
Assessment Results (Pass/Fail)	No
Subject Panel	Physical Sciences
Moderator	Carlos Garcia
External Examiner	D Faux
Accreditation Details	
Changes/Version Number	2.02

Assessment: (also refer to Assessment Outcomes Grids below)
Coursework: 60% of the marks will be from scheduled course-work with feedback. There will be two pieces of written course attracting a total mark of 40% and two laboratory reports based on (mini-projects) attracting a maximum of 20%, with each report assigned a maximum of 10% each of the total marks for the course. Continuous Assessment::There will be two written closed book class tests.. The total marks for the class test will be 40%, with each test having a maximum mark of 20%. Requirements for a pass: To pass students must attain an average module mark of 50%. Reassessment arrangements To be reassessed by re-examination and/or re-submission of coursework. Students are required to contact the School to confirm re-sit arrangements
(N.B. (i) **Assessment Outcomes Grids** for the module (one for each component) can be found below which clearly demonstrate how the learning outcomes of the module will be assessed. (ii) An **indicative schedule** listing approximate times within the academic calendar when assessment is likely to feature will be provided within the Student Handbook.)

Assessment Outcome Grids (Footnote A.)

Component 1

Assessment Type (Footnote B.)	**Learning Outcome (1)**	**Weighting (%) of Assessment Element**	**Timetabled Contact Hours**
Class test (written)	✓	40	0
Portfolio of written work	✓	40	0
Report of practical/ field/ clinical work	✓	20	0
	Combined Total For All Components	100%	0 hours

Footnotes

A. Referred to within Assessment Section above

B. Identified in the Learning Outcome Section above

Note(s):

1. More than one assessment method can be used to assess individual learning outcomes. 2. Schools are responsible for determining student contact hours. Please refer to University Policy on contact hours (extract contained within section 10 of the Module Descriptor guidance note). This will normally be variable across Schools, dependent on Programmes &/or Professional requirements.

Equality and Diversity
The programme team have considered how the programme meets the requirements of potential students irrespective of age, disability, political belief, race, religion or belief, sex, sexual orientation, social background or any other protected characteristic. Students/participants with special needs (including additional learning needs) will be assessed/accommodated and any identified barriers to particular groups of students/participants discussed with the Enabling Support Unit (for further details, please refer to the UWS Equality, Diversity and Human Rights policy). Further guidance is available from CAPLeD, Student Services, School Disability Co-ordinators or the University's Equality and Diversity Co-ordinator. (N.B. Every effort will be made by the University to accommodate any equality, diversity and human rights issues brought to the attention of the School) UWS Equality and Diversity Policy
(N.B. Every effort will be made by the University to accommodate any equality and diversity issues brought to the attention of the School)