University of the West of Scotland
Module Descriptor

Session: 2022/23

Title of Module: Thin Film Material Science			
Code: PHYS11010	**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:	Shigeng Song		

Summary of Module

The module offers advanced study at Level 11 of the material science that underpins the understanding of thin films. It is suitable for all Level 11 students with an undergraduate science/materials related degree, and is a core module for students enrolled on the Masters in Thin Films programme at UWS. The module is intended to teach fundamental principles in the control and characterisation of structural morphology and mechanical properties related to thin films, relevant to a broad range of applications.

The module will also cover experimental/analytical skills, and computational skills. The course material will primarily be delivered in lectures. The module also includes practical classes, which will enable students to put into practice the principles covered in the lectures. Part of the practical element is laboratory based (e.g. lab session to study temperature dependant stress in thin films, and analysis to extract the linear expansion coefficient and bulk modulus) and part of it will be computer based (e.g. use of Finite Element Analysis to study the mechanical properties and stress in thin films). There is online support for this module on the Moodle internet resource. The module is assessed by continuous assessment.

A brief outline of the syllabus is given below:

Characterisation of structural morphology, with particular focus on both the short and medium range order, e.g. transmission electron microscopy (TEM), X-ray absorption spectroscopy (XAS), and nuclear magnetic/electron paramagnetic resonance (NMR/EPR).

Techniques to control the structural morphology (zone controls, constrained growth, kinetics and bonding potentials).

- Atomic modelling techniques e.g. use of reduced density functions (RDFs).
- Microstructural control in thin films (grain growth, texture, porosity).
- Mechanical properties of thin films (internal stresses in thin films and their causes, analysis and interpretation of internal stress, hardness, delamination & fracture), including the general treatment of multilayers.
- Equilibrium & stability of surfaces (Gibb's free energy and chemical potential of a material surface, surface diffusion).
- Plastic deformation and inelastic behaviour and relaxation effects in thin films.
- 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. Critically understand the principles that describe thin film structural morphology and mechanical properties. L2. Understand methods by which thin film structure can be controlled. L3. Have a practical ability to characterise and model the composite properties of devices utilising thin films. L4. Understanding the applications of thin films with different nano- and micro-structures.	
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. 1. Critical understanding of structural morphology in relation to thin films, in addition to a range of techniques used to probe atomic structure. 2. Critical understanding of how thin film structure can be controlled through physical processes. 3. Extensive, detailed and critical knowledge and understanding of the characterisation of thin films. 4. Broad awareness of the applications of thin films with varying structural properties.
Practice: Applied Knowledge and Understanding	SCQF Level 11. 1. Develop in-depth, hands-on experience of characterisation equipment, available at UWS, for probing atomic structure e.g. XRD, Raman spectroscopy. 2. Critically understand and evaluate the physical parameters that can affect atomic structure within typical deposition processes. 3. Conduct practical experiments and develop FEA computational simulations to predict the composite behaviour of devices utilising thin films. 4. Awareness of the relevant applications of thin films in relation to their atomic structure.
Generic Cognitive skills	SCQF Level 11. 1. Critically review the best technique for probing different classifications of atomic structure. 2. Apply critical analysis and evaluation regarding the deposition parameters that control atomic structure. 3. Identify and conceptualise the current challenges faced in relation to control of atomic structure in thin films. 4. Critically review, consolidate and extend knowledge, skills practices and thinking in thin films. 4. Extensively understanding of the role of thin films within composite devices.
Communication, ICT and Numeracy Skills	SCQF Level 11. 1. Communicate effectively with peers, more senior colleagues and specialists. 2. Use a range of thin film design and FEA software for the characterisation and dissemination of thin film properties. 3. Undertake critical and analytical evaluation of the role of atomic structure within various thin film applications.

Autonomy, Accountability and Working with others	SCQF Level 11. 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 undertaken to achieve the module learning outcomes are stated below:	**Student Learning Hours** (Normally totalling 200 hours): (Note: Learning hours include both 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: Donald L Smith (2004), Thin Film Deposition – Principles & Practice, McGraw-Hill. (essential) Auciello and Engemann (1992), Multicomponent and Multilayered Thin Films for Advanced Microtechnologies: Techniques, Fundamental and Devices. (recommended)

H. Mayer (1972), Physics of thin films Parts, I and II. (recommended) B. Lewis, J.C. Anderson (1978), Nucleation and Growth of Thin Films. (recommended) Nalwa (1954) Handbook of Nanostructured Materials and Nanotechnology. (supplementary)
(**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	Des Gibson
External Examiner	D Faux
Accreditation Details	IoP & IET (to be sought when available)
Changes/Version Number	2.02

Assessment: (also refer to Assessment Outcomes Grids below)
Exam to be conducted at the end of the module, assessing across the entire module contents (50%).
Coursework assignment – homework assignment and written report; 1,500 words (15+15 = 30%).
Coursework mini project – Practical/computational-based project, aligned with a thematic section of the module, which will be assessed through a written report; 1,500 words (20%).
(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)	Learning Outcome (2)	Learning Outcome (3)	Learning Outcome (4)	Weighting (%) of Assessment Element	Timetabled Contact Hours
Unseen closed book (standard)	✓	✓	✓	✓	50	0

Component 2

Assessment Type (Footnote B.)	Learning Outcome (1)	Learning Outcome (2)	Learning Outcome (3)	Learning Outcome (4)	Weighting (%) of Assessment Element	Timetabled Contact Hours
Dissertation/ Project report/ Thesis	✓	✓	✓	✓	30	0

Component 3

Assessment Type (Footnote B.)	Learning Outcome (1)	Learning Outcome (2)	Learning Outcome (3)	Learning Outcome (4)	Weighting (%) of Assessment Element	Timetabled Contact Hours
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. 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)