Accessibility statement

The Material World: Chemistry & Applications - CHE00023I

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- **Department**: Chemistry
- **Module co-ordinator**: Dr. Chris Spicer
- **Credit value**: 20 credits
- **Credit level**: I
- **Academic year of delivery**: 2020-21
  - See module specification for other years: 2018-19 2019-20

Module will run

Occurrence	Teaching cycle
A	Spring Term 2020-21 to Summer Term 2020-21

Module aims

This module builds on the knowledge established in Year 1 of the Chemistry programme. It introduces students to the way in which modern materials have changed our lifestyle beyond recognition, providing an insight into the cutting edge of materials chemistry and how it underpins the technological developments expected in the 21st century. The module focuses in particular on how the molecular structure controls the materials properties and connects with real practical applications. The module introduces general aspects in the topic of materials science (structure and physical properties) and considers the origins of nanotechnology in colloid science. It then goes on to explore specific applications of modern materials, in LCD technologies, energy storage devices, and biomedical technologies . These concepts are followed by studying how nanotechnology is increasingly being integrated into modern advanced materials. In particular, the course will illustrate how developing materials with well-defined molecular nanostructures can lead to new types of behaviour and high-tech applications – for example in optical electronics, imaging and nanomedicine.

Module learning outcomes

Subject content

- To examine how the structures of molecules can affect the physical properties of a material, in particular the relationship between molecular structure and mechanical, magnetic and electrical properties
- To understand how colloidal materials emerge when interfaces between different phases are stabilised
- To predict how molecular systems assemble into micelles, vesicles or gels, and to comment on the unique properties and applications they have.
- to see how the optical and dielectric properties of liquid crystals and liquid crystal polymers are used in modern TVs and computer screens.
- to understand the importance of the chemical approach to nanomaterials
- to study the preparation, analysis and applications of metal nanoparticles.
- to examine how polymer structure dictates the structure of hydrogels and fibrous materials for tissue engineering.
- to correlate the properties of a biomaterial to its interaction with cells and tissues.
- to identify key biomaterial design properties that dictate their end application in the treatment of disease.

- to understand the analytical techniques involved in identifying energy/electron transfer and redox processes from organic molecules
- to interpret analytical data for extracting information about energy levels in organic materials
- to understand the working design principles and applications of organic materials in modern energy devices (BHJ solar cells, OLEDs and rechargeable batteries)

Academic and graduate skills

- Students will be able to explain the link between materials properties and molecular structure.
- Students will gain an insight into how fundamental chemistry plays a vital role in informing the assembly of nanomaterials and how synthetic chemists are an essential part of the 'nano-revolution'

Module content

***Module content*:**

A physical view of materials science (MAB, 6 lectures, 1×1h workshop)

- Structure of solids and liquids
- Defects in materials
- Elasticity and deformation
- Surfactants and micelles
- Electronic properties of materials
- Magnetism

Self-assembly of colloidal structures (DKS, 4 lectures, 1×1h workshop).

- An introduction to colloidal materials in the world around us - to understand the origins of nanotechnology in much earlier developments in colloid science.
- Micelles and Vesicles - Surfactant structure, design and self-assembly.
- Gels - Gelator structure, design and self-assembly.
- Unique properties and applications of micelles, vesicles and gels - an introduction.

Nematic Liquid Crystals and Modern Displays (SJC, 7 lectures, 1×1h workshop).

- Structures of the nematic liquid crystal mesophases.
- Physical properties of anisotropic fluids and understanding how the properties are related to structure of the liquid crystal material.
- Synthesis of nematic liquid crystals.
- Formulation of nematic liquid crystals for applications.
- Applications of chirality in nematic liquid crystals for uses in temperature sensors
- Introduction to lyotropic liquid crystals and how structure drives self-organisation.

Inorganic Nanoparticles (VC, 6 lectures, 1×1h workshop, 1×1h assessed workshop)

- Preparation and stabilisation of inorganic nanoparticles.
- Tools for nanoparticle characterisation.
- Size and shape-dependant nanoparticle properties.
- Applications of nanoparticles.

Biomaterials (CDS, 6 lectures, 1×1h workshop)

- An introduction to biomaterials and their roles in the treatment of disease
- Hydrogels and fibrous polymers
- Inorganic and ceramic biomaterials
- Controlling biological interactions
- Correlating material processing to structure and activity
- Cutting-edge applications in biomaterial design

Organic Energy Materials (AJA, 6 lectures, 1×1h workshop)

- Pi-Conjugation, energy/electron transfer and organic redox processes
- Aggregation-induced quenching vs aggregation-induced emission
- Conjugated polymers: Organic thin-film semiconductors, photovoltaics (solar cells),
- Molecular optoelectronics: organic LEDs and TADF emitters

- Building a better battery: Rechargeable organic energy storage materials
- Enhancing material properties with hybrid-molecular and multidimensional interactions

Assessment: inorganic nanoparticles assessed by assessed workshops; closed examination: students answer two compulsory questions.

Assessment

Task	Length	% of module mark
24 hour open exam The Material World: Chemistry & Applications	N/A	80
Practical Assessed workshop : Inorganic Nanoparticles	1 hours	20

Special assessment rules

None

Additional assessment information

Assessed workshop on Inorganic Nanoparticles in week 10.

Closed exam: 2 questions, answer both questions. All courses except for inorganic nanoparitcles contribute to the close exam.

Reassessment

Task	Length	% of module mark
24 hour open exam The Material World: Chemistry & Applications	N/A	80
Practical Assessed workshop : Inorganic Nanoparticles	1 hours	20

Module feedback

Students will receive feedback on their performance in their assessed workshop within 4 weeks. Oral feedback for the formative workshops will be given during the sessions.

Closed exam results with per-question breakdown are returned to the students via supervisors within 5 weeks (as per special approval by the University Teaching Committee). Outline answers are made available via the Chemistry web page when the students receive their marks, so that they can assess their own detailed progress/achievement. the examiners' reports for each question are made available to the students via the Chemistry web pages.

Indicative reading

To be provided by individual tutors: this is a research-led course so up-to-date scientific publications will form the majority of the reading.

reasonably considered to be necessary by the University. Where appropriate, the University will notify and consult with affected students in advance about any changes that are required in line with the University's policy on the Approval of Modifications to Existing Taught Programmes of Study.

Coronavirus (COVID-19): changes to courses

The 2020/21 academic year will start in September. We aim to deliver as much face-to-face teaching as we can, supported by high quality online alternatives where we must.

Find details of the measures we're planning to protect our community.

Course changes for new students