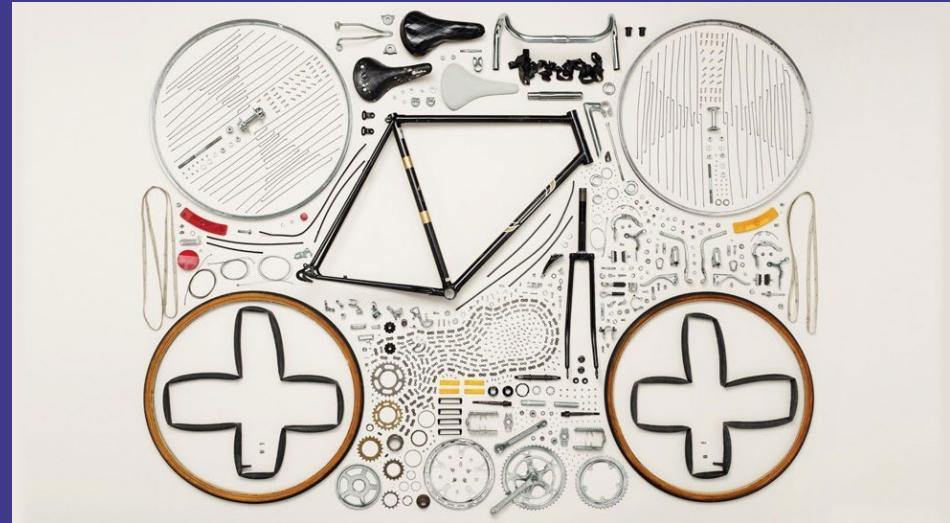


Materials and Manufacturing



Introduction to Materials and Manufacturing

Dr. Billy Wu
Course Leader
Reader (Associate Professor)
billy.wu@imperial.ac.uk

Dyson School of
Design Engineering

About me

2006-2010

Imperial - Mechanical Engineering (MEng)

- 2009 – Summer intern @ Nissan, Japan – Fuel cell and battery research centre
- 2010 – Masters project on fuel cell system control
- 2010 – Student project manager for the fuel cell R&D division of Imperial Racing Green



2009 – Nissan Fuel Cell Research Centre, Japan

2010-2014

Imperial - Earth Science and Engineering (PhD)

- PhD funded by Nissan Japan on fuel cell hybrid electric vehicle modelling and testing
- Fuel cell R&D theme leader for Imperial Racing Green
- Undergraduate teaching assistant – Computing, Mathematics, Materials, Heat Transfer



2013 – BBC Media City promoting fuel cells

2014-2015

Imperial - Earth Science and Engineering (Post-doc)

- Modelling and testing electrochemical energy storage devices for grid applications
- Fuel cell R&D theme leader for Imperial Racing Green



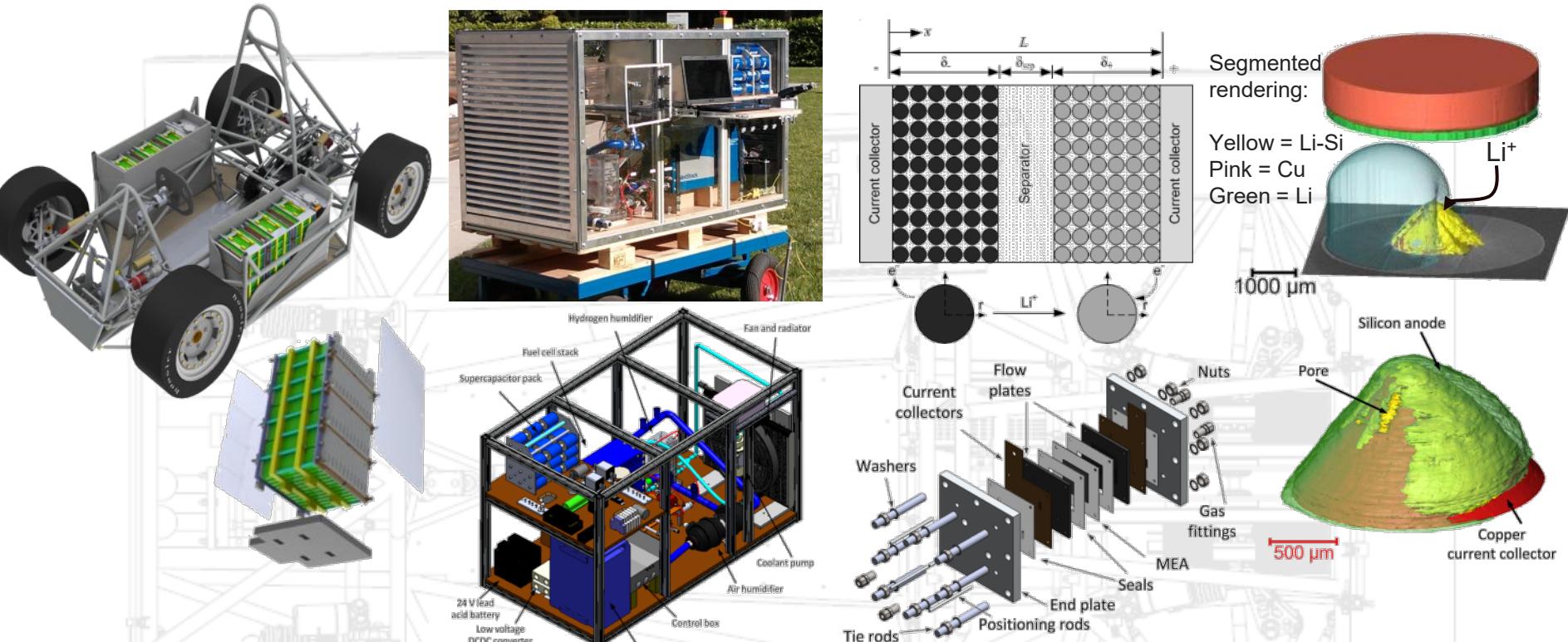
2015 – Joined Design Engineering

2015-present

Imperial – Design Engineering (Lecture-Reader)

- Module leader Materials and Manufacturing, DE4 co-ordinator
- Co-leader of the Electrochemical Science and Engineering group
- Director of Research
- Many other things

What do I do?



Battery Electric Vehicles

- Module design
- Performance limitations
- Novel diagnosis techniques
- Mechanical testing

Hydrogen fuel cells

- System design + control
- Novel low cost configurations

Modelling

- Physical modelling of lithium-ion batteries, hydrogen fuel cells for EV and grid

New materials

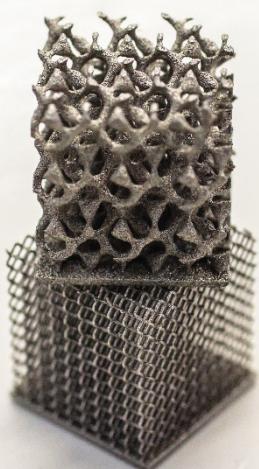
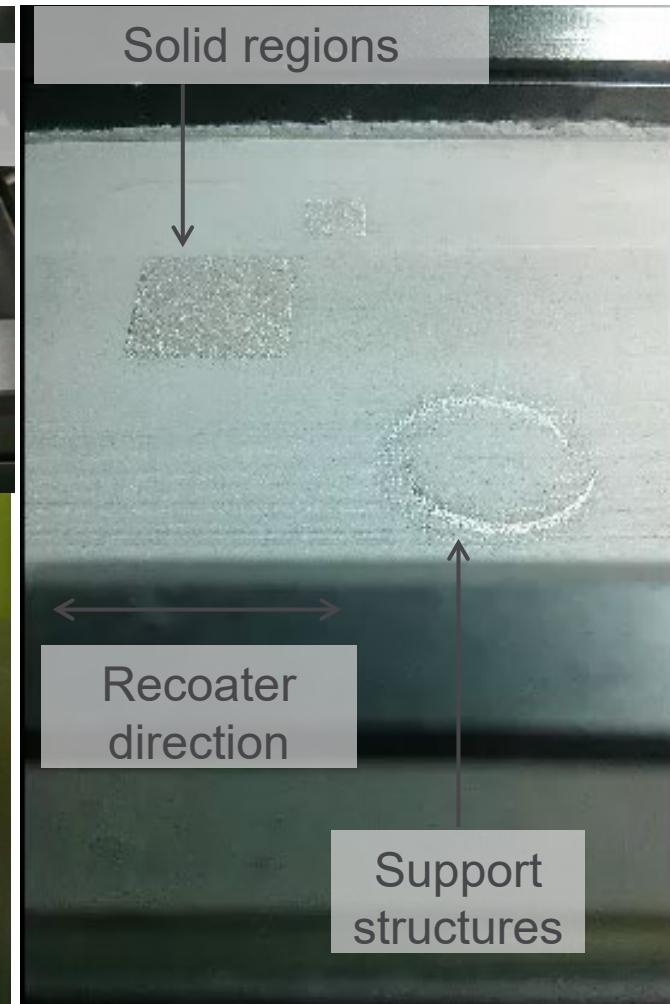
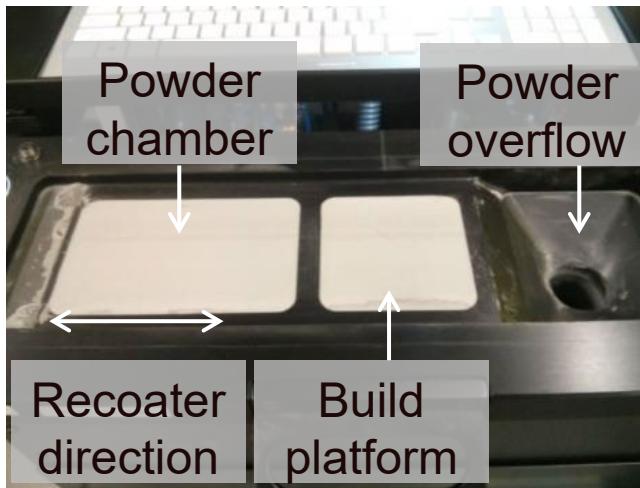
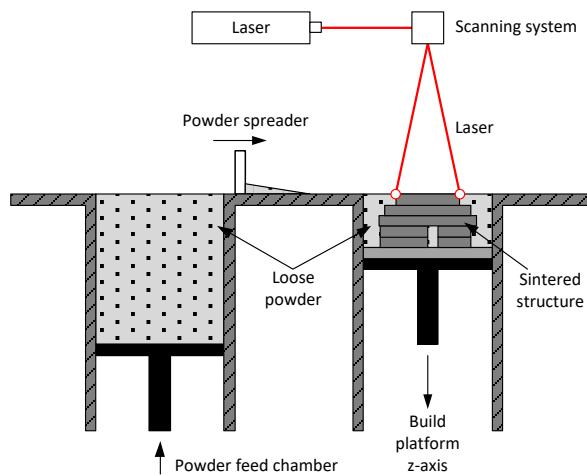
- Lithium-silicon
- Lithium-sulphur
- Metal-air batteries
- Redox flow cells

Multi-length scale

Metres - Engineering

Microns - Science

3D printing



The finished product

Video 4x real time speed

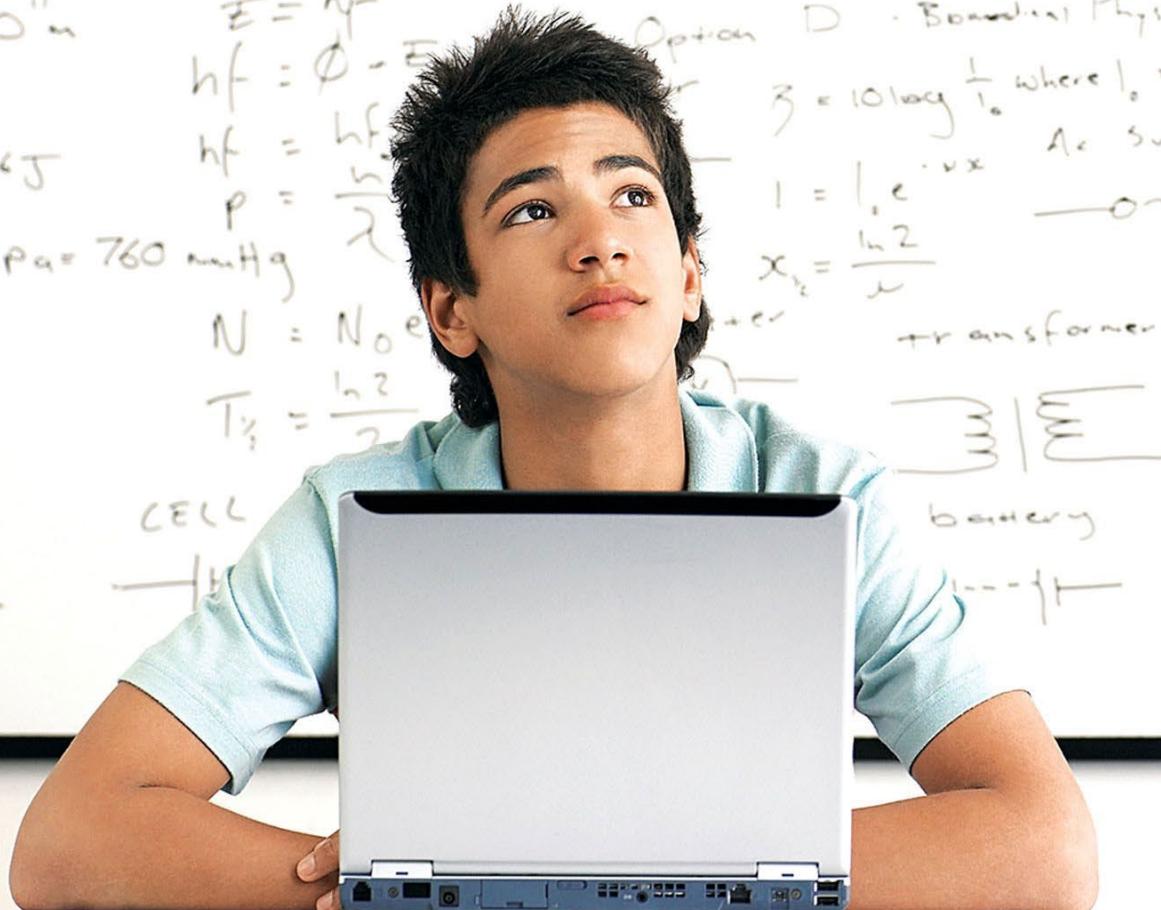
Dr. Chandra George

Royal society
research fellow
and lecturer

chandramohan.george@imperial.ac.uk



What would you like to get out of M&M?



Imperial is a “special” place

Who is this?



Dr. Brian May
PhD in Astrophysics
Imperial College London



Water cooler chat

“So Andy, what will our students be the best in?...”



“...Being able to handle ambiguity”

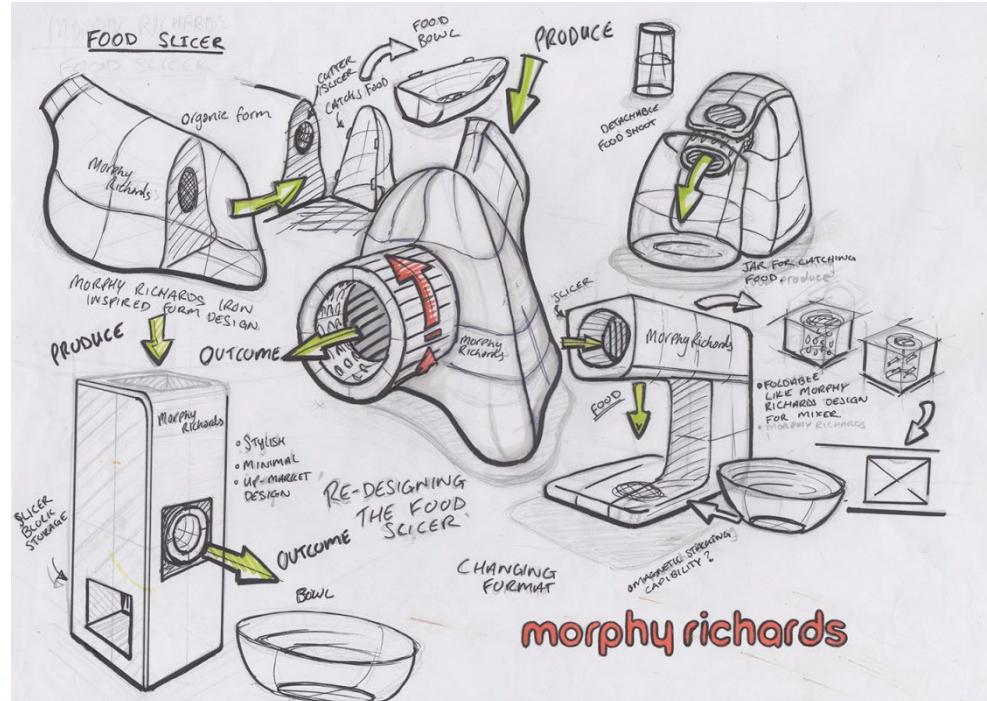
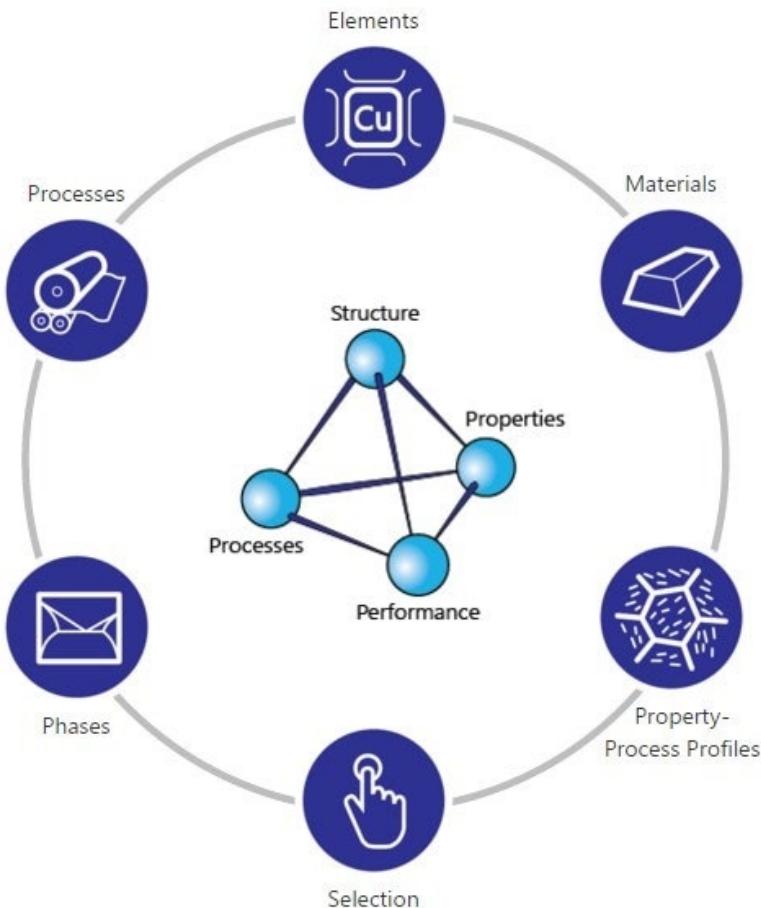


“...Erm... OK”



Why are we here?

To equip student with fundamental knowledge of material science and manufacturing and their linkages to design



Intended Learning Objectives

On successful completion of the module, students should be able to:

Materials

- Describe common engineering materials and apply them based on their properties
- Understand how materials contribute to user experience
- Evaluate appropriate materials for an application based on their properties

Manufacturing

- Define the capabilities of a range of common production techniques
- Assess appropriate production techniques for different materials and applications
- Evaluate appropriate methods of assembly and joining for a particular design application

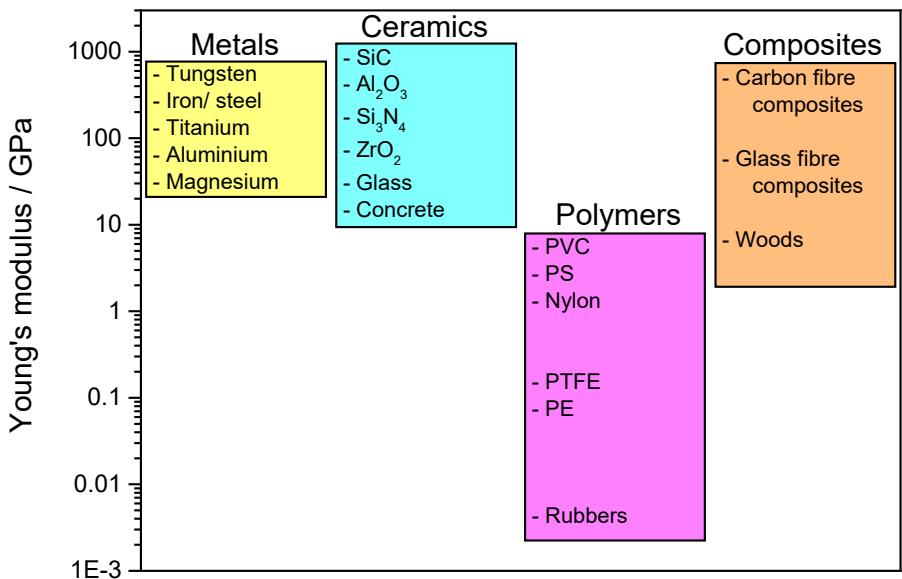
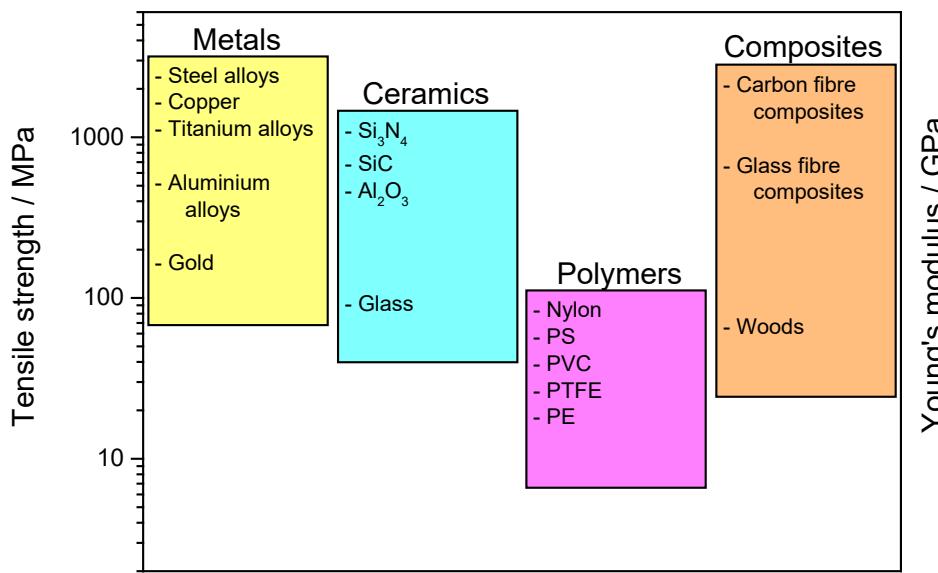
Progressive learning

Bloom's Taxonomy of Learning

Domain		Example wording
Combining parts to create new knowledge	Create	Derive, formulate, propose, create, generate, plan, produce
Judging the value of information or ideas	Evaluate	Judge, assess, evaluate, compare, critique
Breaking down information into component parts	Analyse	Distinguish, calculate, solve, differentiate, organise, attribute
Applying the facts, rules, concepts and ideas	Apply	Use, demonstrate, illustrate, execute, implement
Understanding what the facts mean	Understand	Explain, compare, summarise, classify, exemplify, interpret
Recognizing and recalling facts	Remember	Define, describe, state, name, recognise, recall

https://youtu.be/M3oR_s_oWgs

Engineering materials

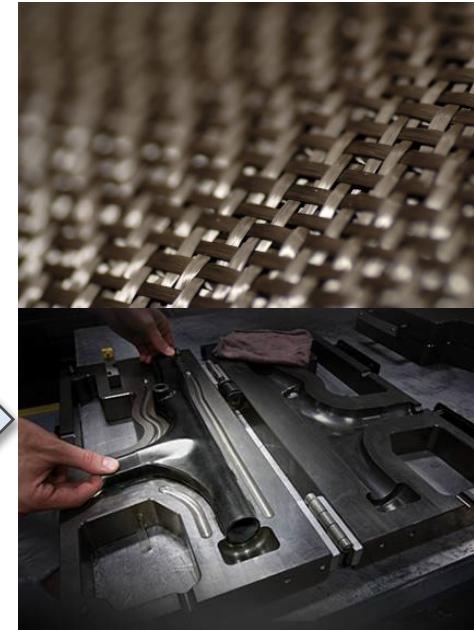


Materials through to products

Material science



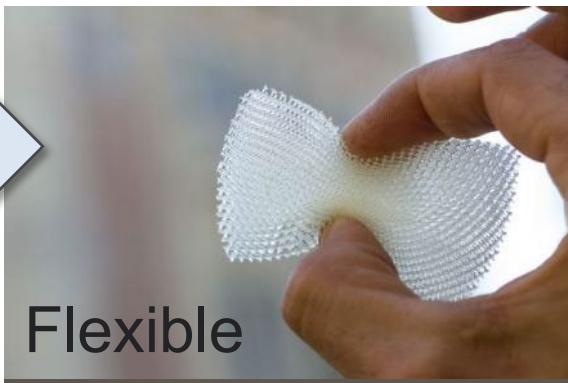
Materials
Engineering
Augmenting properties



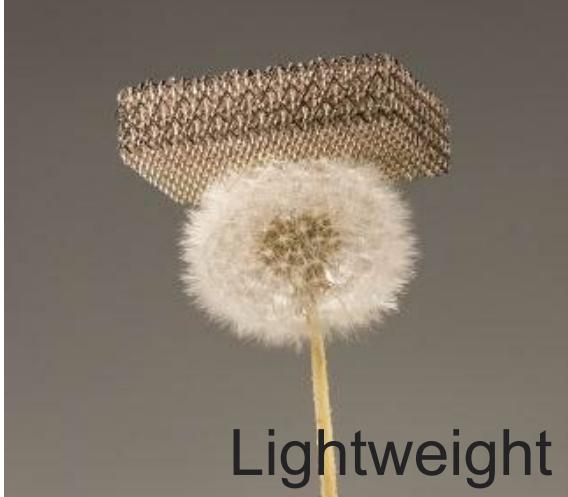
Elastic



Flexible



Lightweight

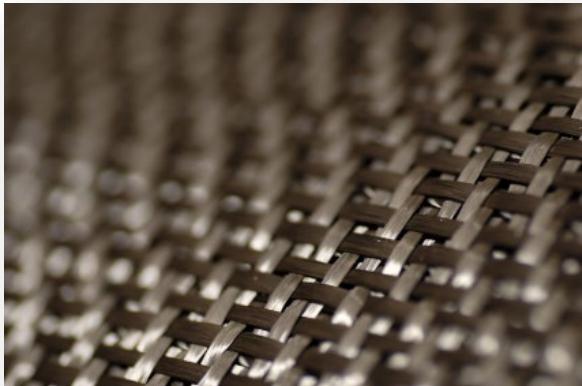


Product
manufacturing

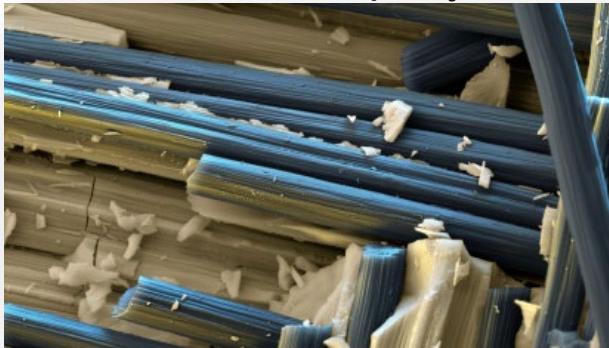


Real world applications

Carbon fibre layup



Carbon fibre and epoxy bonding



Moulding



Making carbon fibres



Assembly



Joining



Real world applications



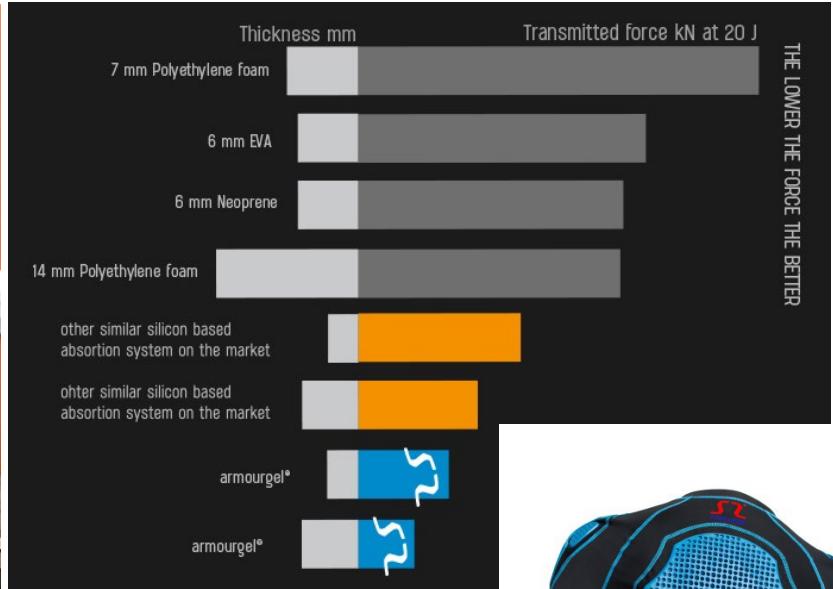
Shear hardening materials
Flexible but safe clothing

Real world applications



Rheon

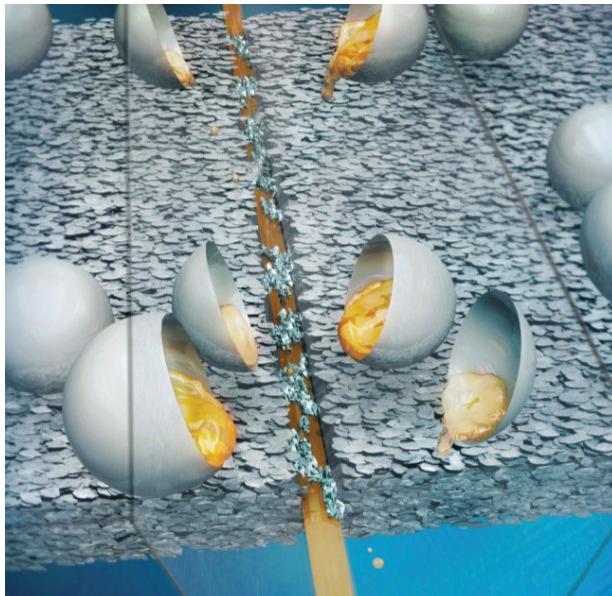
@ImperialMechEng – Dr. Dan Plant
shows off new lifesaving technology



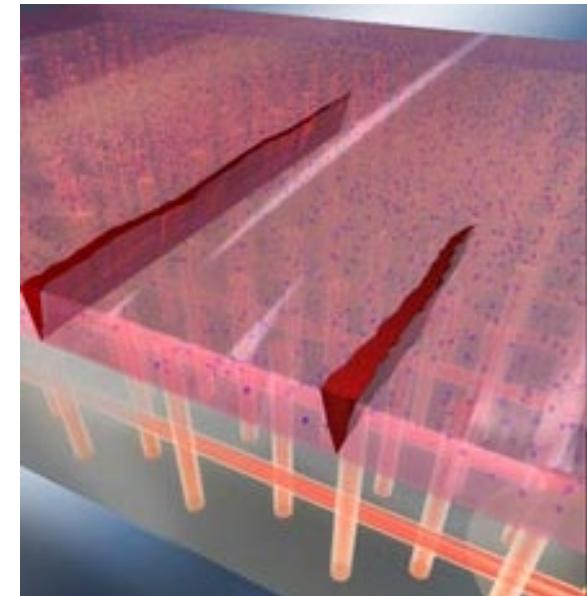
Self healing materials



Concretes



Polymers



Steel coatings

Course timeline

Term 1

Materials

Materialise

Materialise hand-in

Term 2

1.5 hour materials exam

Manufacturing

REVENG

REVENG hand-in

Term 3

1.5 hour manufacturing exam



Marks breakdown



Materials
consultancy
coursework
25%

1.5 hour
materials
exam
25%



REVENG
coursework
25%

1.5 hour
manufacturing
exam
25%



Materials overview

Properties
and
applications
of materials

Metals,
polymers,
ceramics
and
composites

Material
failure

L1.2 – Introduction to material science

L1.3 – Applications of advanced materials

L1.4 – Mechanical properties of materials

L1.5 – Materials experience

L1.6 – Metals and engineering alloys I

L1.7 – Metals and engineering alloys II

L1.8 – Altering material properties

L1.9 – Polymers

L1.10 – Ceramics and glasses

L1.11 – Composites

L1.12 – Recycling, selection and design

L1.13 – Material corrosion

L1.14 – Material failure

L1.15 – Case studies

L1.16 – Materials overview



Manufacturing overview

Solidification processes

Metal working

Surface treatments,
joining and assembly

Overview

L2.01 – Introduction to manufacturing technologies

L2.02 – Casting processes

L2.03 – Plastic processing

L2.04 – Polymer composite processing

L2.05 – Ceramic processing

L2.06 – Additive manufacturing

L2.07 – Fundamentals of metal forming

L2.08 – Sheet metal forming

L2.09 – Machining operations

L2.10 – Non-traditional machining processes

L2.11 – Surface treatments

L2.12 – Welding

L2.13 – Brazing, soldering and adhesives

L2.14 – Mechanical assembly

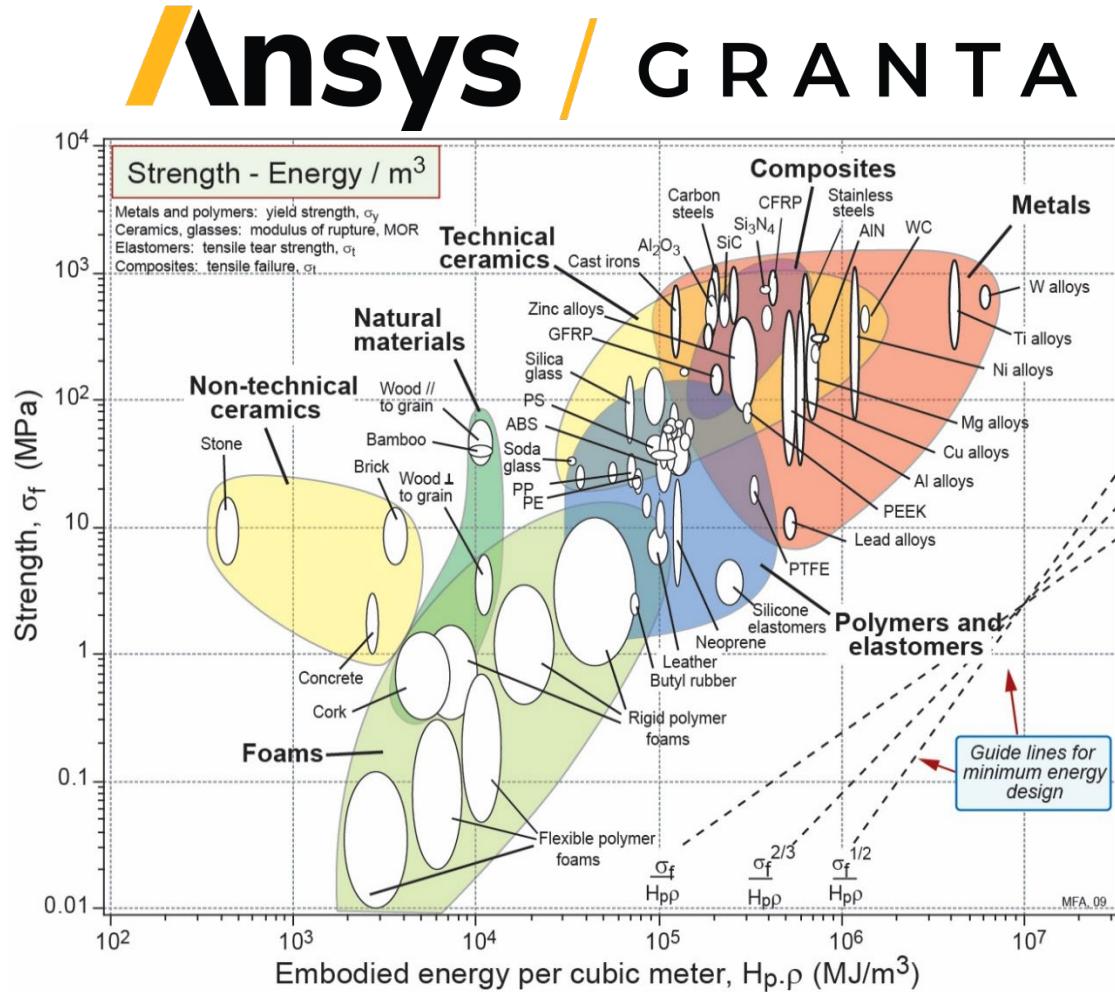
L2.15 – Real world applications

L2.16 – Revision lecture



Materials library – Which one?

- Developing the brief
- Figures of merit
- Develop critical thinking



How are things made?
How can we make them better?

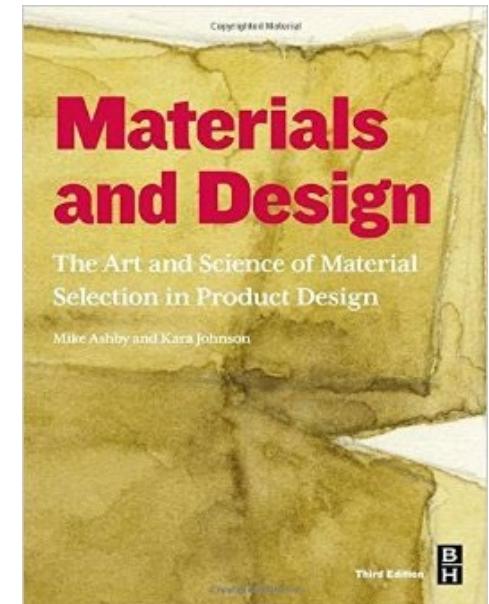
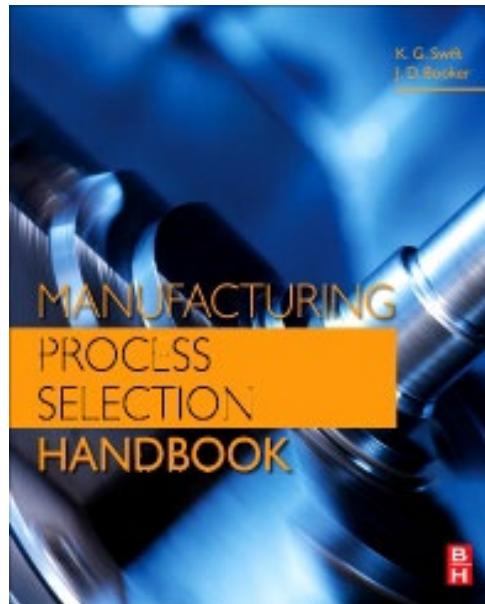
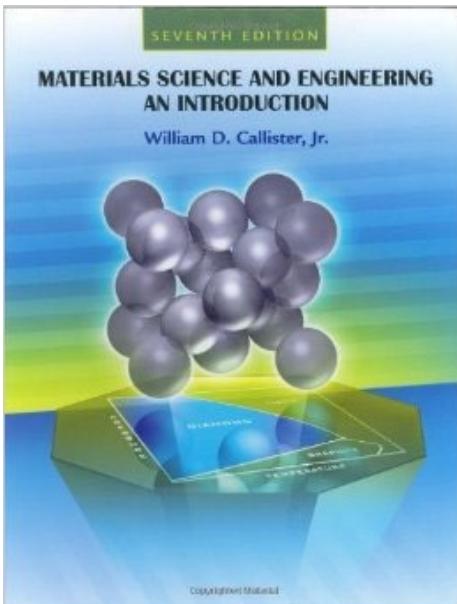


Over-engineering

Just because you can doesn't mean you should

Extra reading

- W.D. Callister. **Materials Science and Engineering: an Introduction.** Wiley.
- K.G. Swift and J.D. Booker. **Manufacturing process selection handbook.** Butterworth-Heinemann
- M. F. Ashby and K Johnson. **Materials and Design: The art and science of material selection in product design.** Butterworth-Heinemann



Resources

Materials and Manufacturing (DE1-M&M)
Materials science and engineering: From atoms to applications
Dyson School of Design Engineering
Dr. Billy Wu and Dr. Chandramohan George
2021–2022

Notes + tutorials

Dyson School of
Design Engineering

Imperial College London | Faculty of Engineering

Course Content

DE1-PMAT Production and Materials (2015-2016)

Stay Updated

Discover & Learn

Study Resources

Blackboard+Teams



Lecturers and tutors

Flipped classroom



Learn more about it and also my teaching ethos

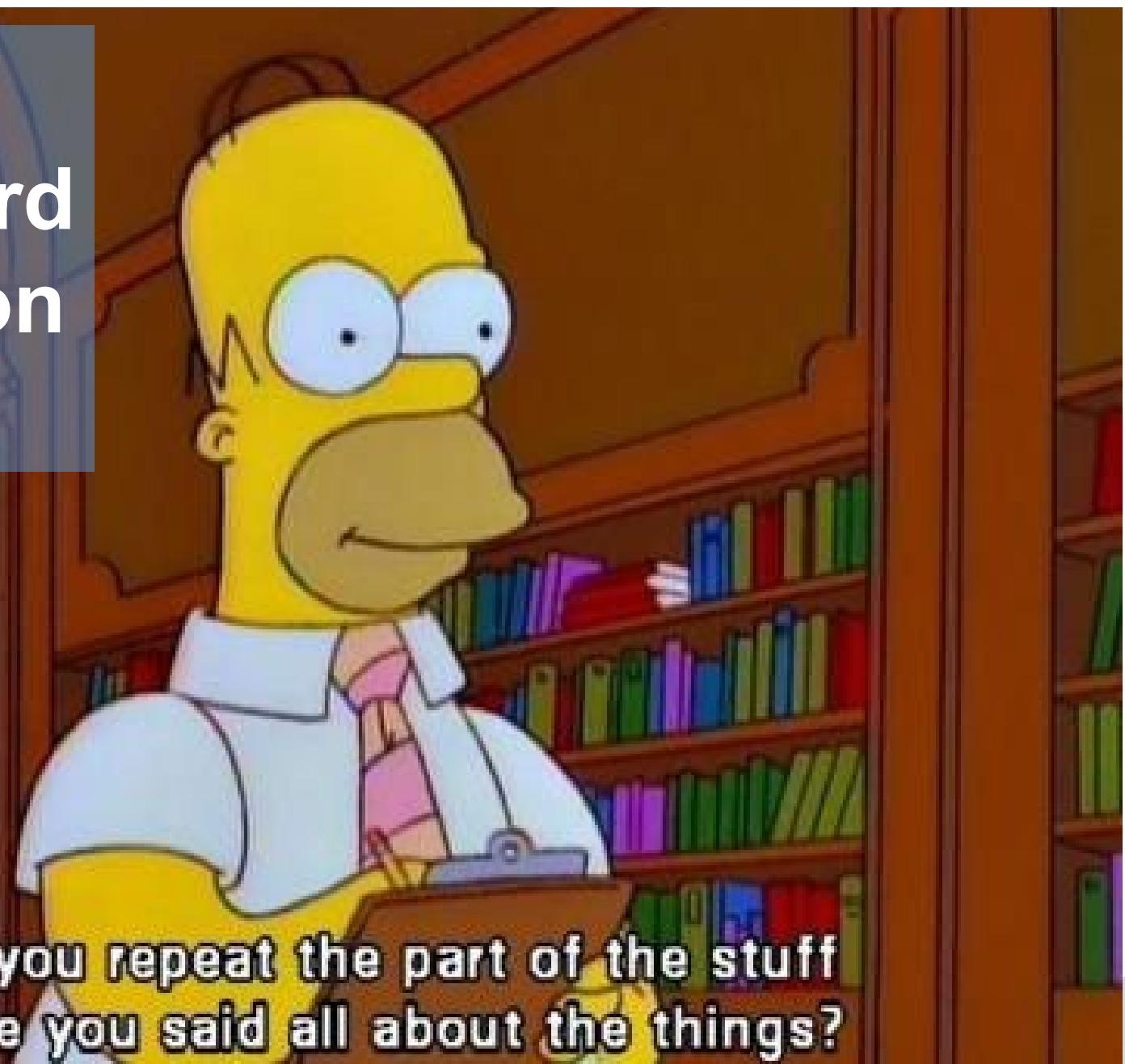
<https://www.linkedin.com/pulse/meta-teaching-teaching-digital-age-billy-wu/>

Access flipped classroom videos

<https://youtube.com/playlist?list=PLAkf2LZiuWhlzpsUuth8rpXBAs8SJh3FQ>

Don't be afraid to ask questions

Use the
Blackboard
discussion
forum



Can you repeat the part of the stuff
where you said all about the things?

My door is open

- Will try and reply e-mails as quick as possible
- 1M04A – Observatory building side
- billy.wu@imperial.ac.uk



Lectures

Term 1

Lectures

Monday 14:00-15:00
Roderic Hill 409

Wednesday 09:00-10:00
Studio 3

Tutorials

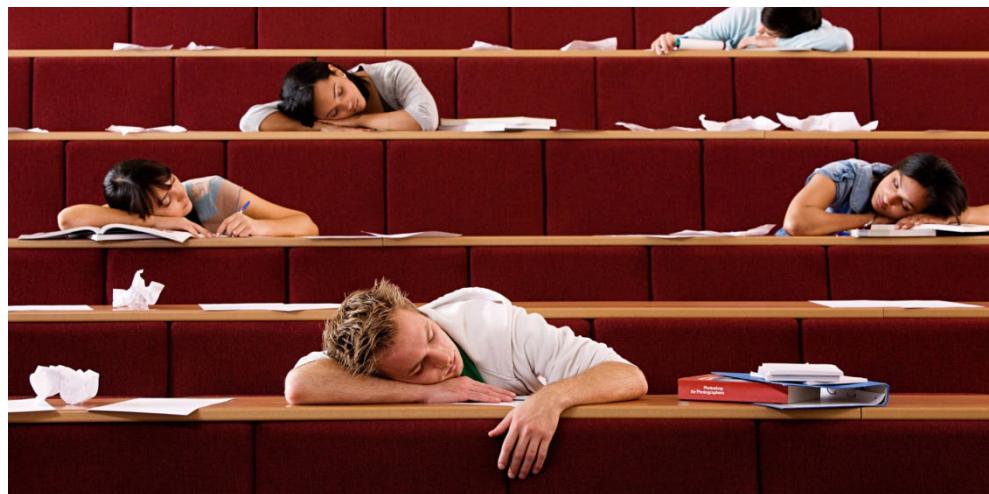
Quiz

Wednesday 10:30-11:00
Studio 3

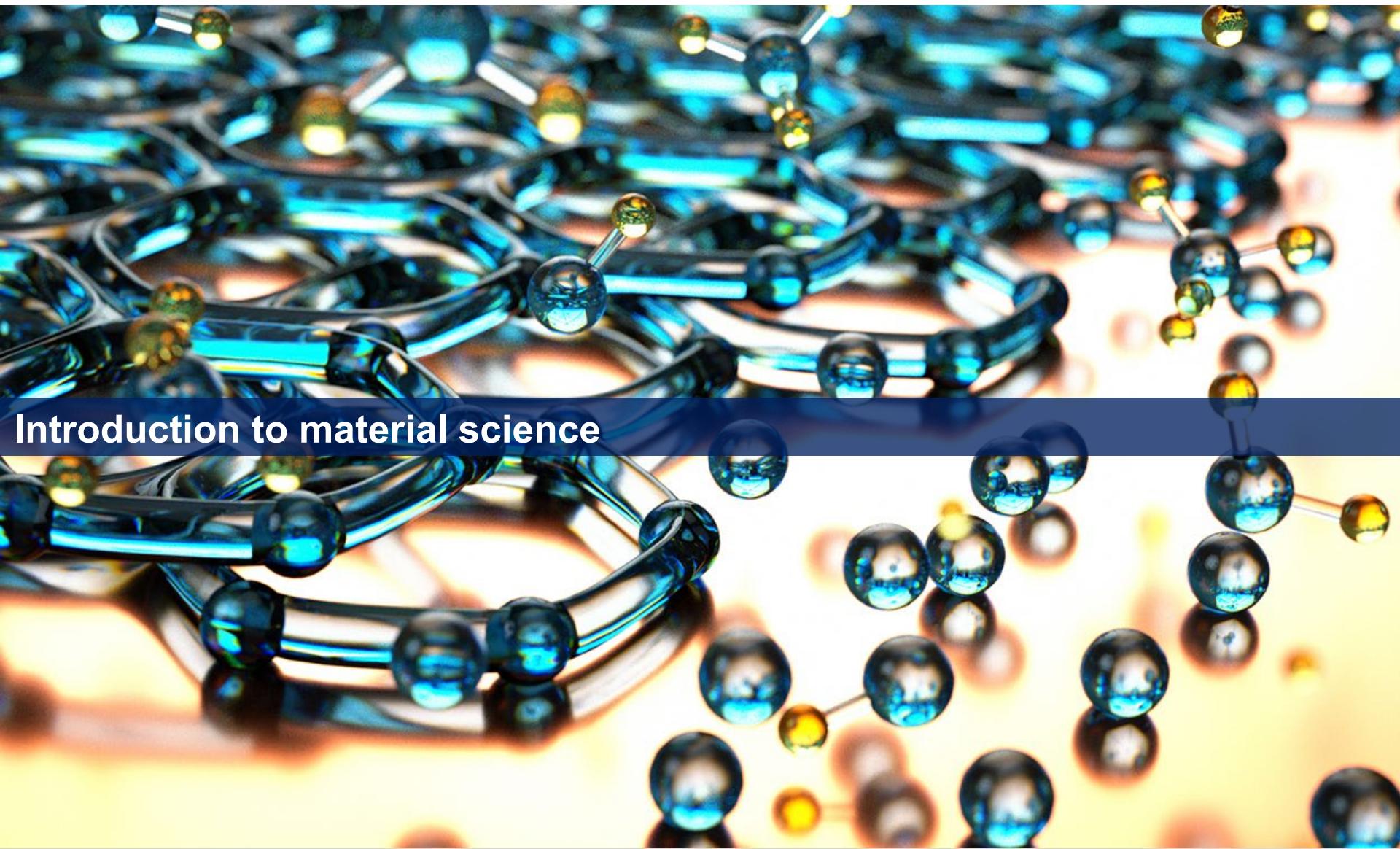
General tutorial

Wednesday 11:00-12:00
Studio 3

Friday 14:30-15:30
Studio 3



Next time in M&M



Introduction to material science