



Nanotechnology and Electric Vehicle Battery Technology Application

Course Syllabus, 2020 CSAP-U ResearchPlus

Course Dates

20th July to 8th August, 2020 (Session I)

Course Duration

3-Week

Credit Equivalency:

3 US

Prerequisites

Mathematical literacy is essential. Understanding of how to solve simple ordinary differential equations is useful. Some knowledge of basic Physics useful.

Assessment

Assessed individually and in groups through group presentations

Skills Trained

Problem Solving, Teamwork, Presentation, Communication

Materials Required

Internet connection and Laptop for writing, researching and preparing presentations

Course Description

We will take a look at Nanotechnology in everyday use, gain an understanding of the basic underpinning principles and see where this exciting field is heading. We will start by looking at the origins of nanotechnology, deep in the mists of time when science thought it had all the answers, and then it became

clear from one discovery after another that this was not the case. We will then look at what nanotechnology really is, and how and why the properties of nanometer-sized objects are fundamentally different to larger things, and how we can take advantage of this. We will look at specific examples of nanotechnology applications in a number of different industry sectors. Then we will look at battery technology and what the requirements of batteries in



electric vehicles are. Having seen this, it will become clear that Nanotechnology has much to offer and we will explore how to optimize battery performance using nanotechnology.

Course Topics

1. Nanotechnology, an Introduction
2. Properties of Nanostructures and Nanomaterials
3. Battery technology – basics
4. Nanotechnology in batteries and applications to Electric vehicles

Goals & Objectives

By the end of this course, participants will be able to:

1. Have an appreciation of the fundamental scientific principles underpinning Nanotechnology
2. Analyze the key industrial sectors where Nanotechnology is used and assess the impact
3. Understand the basic structure of batteries used in Electric vehicles and what Nanotechnology has to offer
4. Learn how to do research, analyze cases, solve practical problems, and write an English paper.

Assessment:

Class Discussion/Participation: 15%

Group presentation: 50%

Final Research Paper: 35%

Final Project:

Final project consist of two parts: a group presentation and research paper. The group presentation will be a group project and each group will choose one of the following topics:

1. Nanotechnology in industry – choose an industry sector and look at how it uses nanotechnology.
2. Fundamentals of Nanotechnology – how the field started and the initial promise.
3. Nanomaterials – what they are and where they are used.
4. Nanotechnology in Battery technology as applied to electric vehicles – application and limits.

The research paper is an individual assignment due two weeks after the programme. Each student will write a maximum 2-page A4 paper (less than 1,000 words). Each student will come up with their own topic related to the group presentation project.



Professor Bio:

Colm Durkan is a Reader in Nanoscale Engineering at the University of Cambridge and is the Deputy head of the Engineering Department in charge of teaching. He obtained his degree and PhD in Physics from Trinity College Dublin during which time he designed and constructed the first scanning near-field optical microscope (SNOM) in the country, and made significant advances in our understanding of the mechanisms behind image formation in such systems. He then spent a year in Konstanz, Germany working in collaboration with ZEISS on the construction of a commercial microscope system.

In 1997 he moved to the University of Cambridge, initially as a research associate in the Nanoscale Science group, and since 2000, as a faculty member. During this time he has led a research group consisting of around 10 members, been head of the Nanoscience centre for four years (2009-2010 and 2015-2016), published over 80 papers, given over 100 talks, written a successful textbook on Nanoelectronics, and developed several scanning-probe microscopes and new measurement techniques. He has also just completed a popular science book on Nanotechnology for the layperson.

Colm has secured funding from and collaborated with several leading companies as well as government funding agencies, to the tune of over £3 Million in the past few years. He lectures and teaches in electronics, electromagnetism, quantum mechanics and nanotechnology. He is on the editorial board of Ultramicroscopy and Imaging & Microscopy, and is a fellow of Girton College, Cambridge, the Institute of Physics and the Institution of Engineering and Technology.

Format

Zoom will be the primary tool to conduct the lectures and supervisions. A few other online learning platforms will be used for material delivery, communication, and research paper submission.

For the students from China, other methods might be added on depending on the internet environment at that time.

Reading List

Book “Size Really Does Matter – The Nanotechnology Revolution” by C. Durkan (World Scientific)

Nanotechnology 101 – this is a website from the US government-funded National Nanotechnology Initiative: <https://www.nano.gov/nanotech-101>

There are some useful pages on the website of the Foresight Institute:



<https://www.foresight.org/Hotwired.all.files/index.html>

An insightful discussion can be found here – “Can Nanotechnology save lives?”

<https://www.smithsonianmag.com/science-nature/can-nanotechnology-save-lives-1060517/>

There are some interesting ideas and concepts on this page prepared by the Guardian newspaper:

<https://www.theguardian.com/science/nanotechnology>