

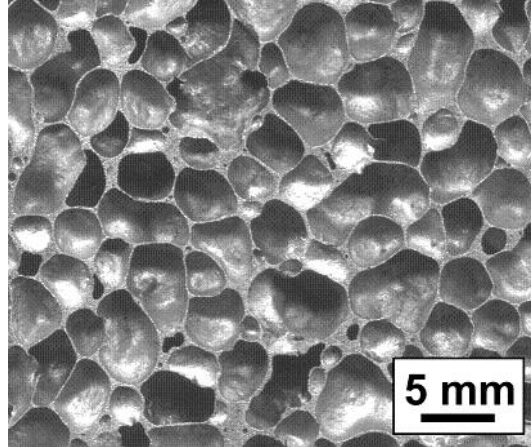
Mechanical, Aerospace and Civil Engineering

Foundation Year Projects (Mechanical)

Supervisor: Dr. Henry Tan

Topic 1: Metal foams

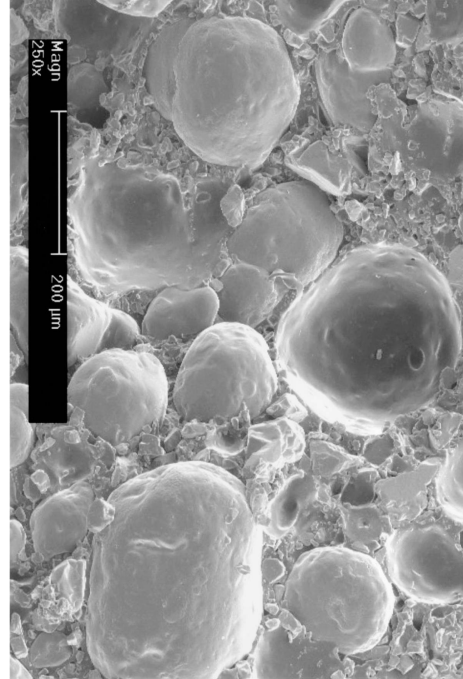
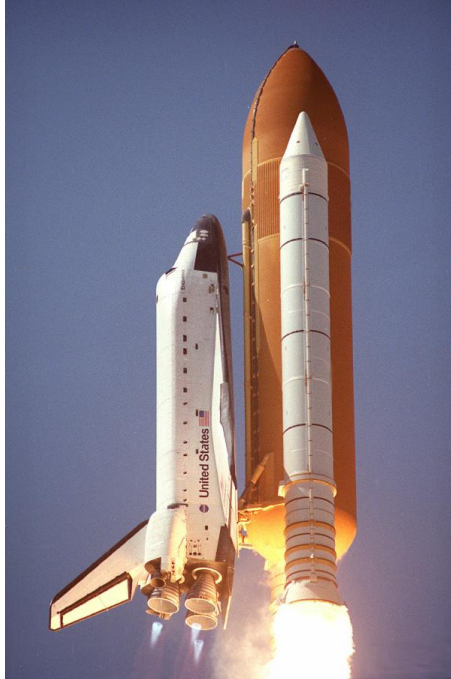
Metal foams have high porosity and three-dimensional net-like structure. This project is to explore their behaviours and applications. The suggested investigations are given in the following. (1) The exceptional ability of metal foams to absorb large amounts of energy suggests applications ranging from automobile bumpers to aircraft crash recorders. (2) The acoustic properties of metal foams mean applications in many places where sound absorption is vital, for example along the sides of a road to reduce traffic noise. You can find more applications for metal foams.



Picture from Shinko Wire Company

Topic 2: Solid rocket propellants

The Space Shuttle solid rocket boosters are the pair of large solid rockets used by the Space Shuttle during the first two minutes of powered flight. The microstructure of solid propellants consists of the fuel and oxidizer stored in a condensed solid state of matter. Green propellant is a family of solid propellants which have properties such as low toxicity, low pollution impact, low cost, safe and stable. Interests on green propellants are increasing with new energetic ingredients being proposed. This project explores how microstructures of solid propellants affect the sensitivity and safety.



Picture from the Center for Simulation of Advanced Rockets annual report, 2006

Topic 3: Explosive demolition in nuclear decommissioning

The cooling towers of the shut down Calder Hall plant at Sellafield, UK – the world's first industrial-scale nuclear power plant – was demolished using explosives on 29 Sept 2007. Generally speaking, nuclear plants were designed for a life of about 30 years (new designs have 40-60 year operating life). The decommissioning of nuclear power plants is referred to as nuclear decommissioning. The overriding issue in nuclear decommissioning is to ensure safety and protection of environment due to the possible presence of radioactive or fissile material in a nuclear facility that requires special precautions. The best way for the demolition phase of nuclear decommissioning is to use explosives. In this project, we focus on the understanding of the sensitivity of explosives, which related to the safety in nuclear decommissioning.



(a) Explosive charges are placed under the towers.



(b) Controlled collapse of each tower.

Picture from the World Nuclear News

Topic 4: Gecko's amazing sticky feet

This project is about materials and structures that are “biomimetic” or “bio-inspired”. Mechanics has a clear role in using natural principles to engineer things with mechanical functions. For example, animals that cling to walls and walk on ceilings owe their ability to micrometre and nanoscale attachment elements. A current idea for adhesives and biomimicry is that of “gecko tape,” where an adhesive system is being designed based on the principles that allow geckos to walk up walls. This project investigates the mechanics of biomimetic or bio-inspired materials.



Picture from Wikipedia

Topic 5: Granular material

A granular material is a conglomeration of discrete solid, macroscopic particles characterized by a loss of energy whenever the particles interact (the most common example would be friction when grains collide). This project explores the dynamics of granular materials, such as energy absorbing, like a sponge, for shock and blast mitigation, and wet behaviours. Wet granular materials have small amounts of liquid added to grains lead to inter-grain cohesion and lubrication, and microscopic amounts of interstitial liquid can result in macroscopic changes in the granular properties.



A physical manifestation of how wet granular materials allow for much steeper slopes than can be obtained with dry grains. Picture from *Science*.

Topic 6: Flexible electronics

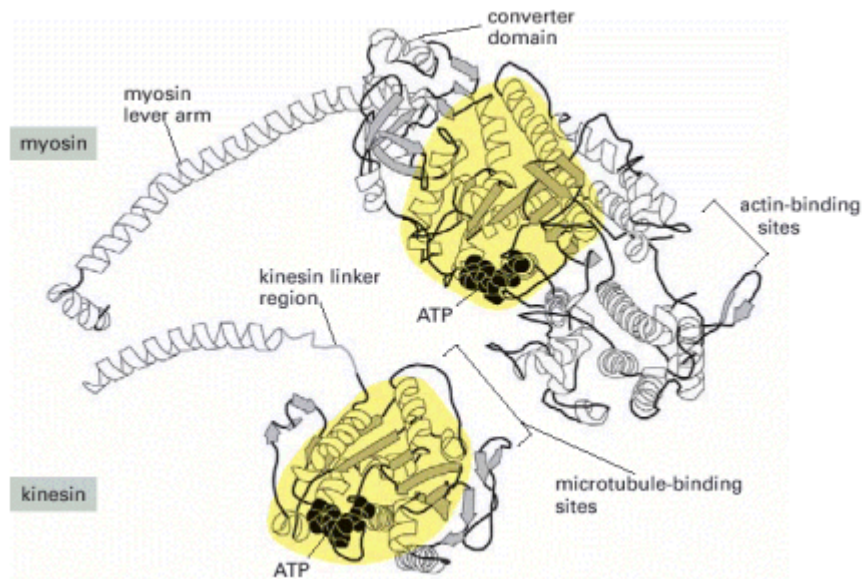
Flexible electronics also known as flex circuits or flex circuit boards, is a technology for building electronic circuits by depositing electronic devices on flexible substrates such as plastic. Flexible electronics is an emerging technology with many exciting applications, such as paper-like displays (as shown in the figure) and skin-like smart prosthesis. These potential applications will profoundly impact various facets of our daily life, and excite our curiosity. Many of such challenges find their origins in the mechanical response of new architecture and material choices, and this will be studied in this project. This project investigates the behaviour and applications of Flexible electronics.



Picture from imechanica.org

Topic 7: Molecular motors

Many fundamentally important biological processes rely on the mechanical response of proteins and their assemblies, including mechanotransduction and molecular motors. Mechanotransduction refers to the many mechanisms by which cells convert mechanical stimulus into chemical activity. Simple movements such as walking depend on the ability to transform mechanical energy in the form of touch, sound, and muscle tension into ionic currents. Only now are we beginning to uncover proteins that are likely constituents of mechanotransduction channels and the protein machinery that couples applied forces and channel activation. The figure below shows the X-ray crystal structures of two proteins. This project investigates the behaviours of mechanotransduction and molecular motors.



Picture from imechanica.org