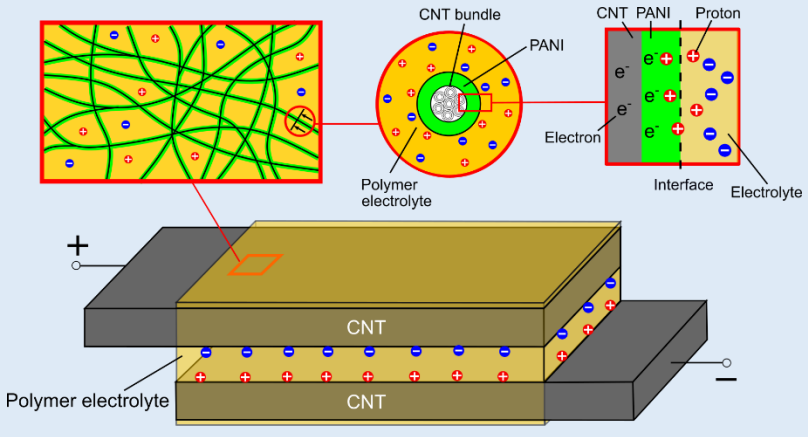
# SEMS: RESEARCH PROJECT DESCRIPTION

## 1. Project Background and Description

Project title: The crashworthiness of batteries or supercapacitors used in electric vehicles

UK is set to replace petrol/diesel cars by electric vehicles (EV) in 2030. This challenging target demands a more energy efficient design of EVs. To achieve this, there are several approaches in addition to developing advance lithium-ion batteries. We can either reduce the total weight of EVs by lightweight materials or make the car structural components into extra energy-storage devices. Carbon nanotube (CNT), as a lightweight material, generated much excitement due their high electrical conductivity and surface area, is of great potential to introduce energy-storage property as well as to reduce the total weight of electric car. Recently, novel multifunctional composite electrodes with the capacity to carry mechanical loads and harvest/store electrical energy have been developed for batteries and supercapacitors by Dr. Tan, see Figure 1 below. Macroscopic CNT mat with thin layer coating of polyaniline on the CNT bundles are used as the high energy-density electrodes for batteries and supercapacitors.

The goal of this study is to explore the crashworthiness of energy devices (batteries or supercapacitors). Safety considerations are especially important when applied to large automotive batteries designed for propulsion of electric vehicles (EV). The high amount of energy stored in EV battery packs translates to higher probability of fire in case of severe deformation of battery compartment due to automotive crash or impact caused by road debris. The crashworthiness of the CNT-based composite batteries is not explored. Therefore, a comprehensive experimental and numerical study of CNT-based composite batteries or supercapacitors under crash or impact loading is essential. The mechanisms leading to internal short circuit need to be understood. Methods to avoid short circuit, thermal runaway or catastrophic failure needs to be developed.



## 2. Project Scope

- To explore the failure behavior of batteries or supercapacitors under impact or crush loading.
- To probe the mechanisms of internal short circuit and thermal runaway of batteries or supercapacitors.
- To quantify the crashworthiness of batteries or supercapacitors using index of energy absorption and electrochemical stability.

## 3. Desired Skills from the Student

- A good Upper Second Degree (or International equivalent) or master degree, in engineering, mechanics, mathematics, physics, materials science, chemistry or other closely-related disciplines.
- Solid background in mechanics of materials, mechanical tests or finite element analysis.
- Excellent English communication and writing skills.

## 4. Supervisory Team

Primary: Dr. Wei Tan, Lecturer in Mechanical Engineering.

Secondary: Prof. James Busfield (FREng), Professor of Materials

Additional: Dr. Paddy Cullen, Lecturer in Renewable Energy