

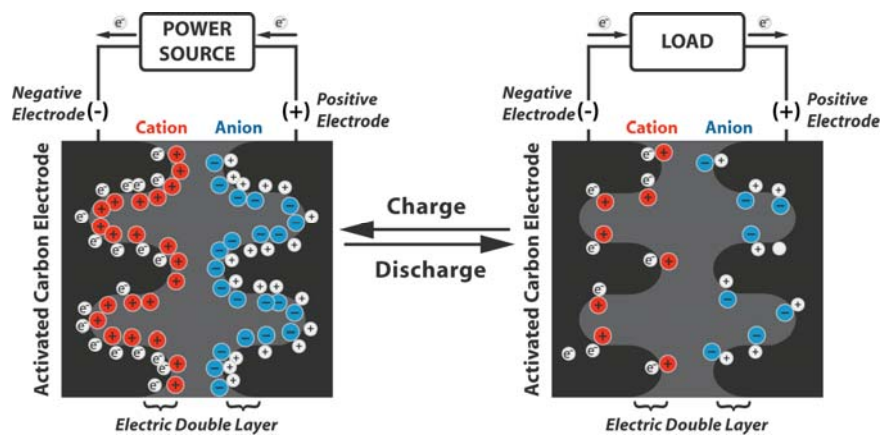
# Fact Sheet – Supercapacitors

## What are supercapacitors?

- Supercapacitors are energy storage systems, which are able to store a large amount of charge (energy) that can be released very quickly. They are essentially a cross between batteries and capacitors
- They overcome a capacitors limited ability to store charge (energy) and a battery's limited capacity for rapid energy delivery

## How Do They Work?

Unlike batteries, which generate energy via chemical reactions, supercapacitors use a physical means, separating out the positive and negative charges, storing energy as electricity. This concept is similar to an electrical charge that builds up when walking on a carpet.



## Supercapacitors versus batteries

Property	Supercapacitor	Battery
Charge/Discharge Time	Milliseconds to seconds	1-10hrs
Operating Temperature	-40 ~ 85 °C	-20 ~ 65 °C
Operating Voltage	2.5 V/ cell	1.25 to 4.2 V/ cell
Life	10 <sup>6</sup> cycles	150 ~ 1500 cycles
Weight	1 ~ 2 g	1 g ~ 10 kg
Power Density	10 ~ 100 kW/kg	0.005 ~ 0.4 kW/kg
Energy Density	1 ~ 5 Wh/kg	8 ~ 600 Wh/kg

### Pros:

- Fast charge/charge - ability to release energy quickly as well as store it quickly
- High power density
- A virtually unlimited life cycle - cycles millions of times –a 10 to 12 year life in comparison to 1000 cycles of rechargeable batteries
- No danger of overcharge and explosion
- High cycle efficiency (95% or more)
- Can be made in any size and shape

### Cons:

- Low energy density - energy released for a short time
- Relatively expensive in terms of cost per watt

## Nanotechnology and supercapacitors

The key components of supercapacitors are the electrodes most commonly made of carbon. Nanotechnology allows the tailoring of the carbon electrode structure at the nanometer scale. Since the amount of energy storage is proportional to the surface area, optimisation of the pore structure is the key for maximum energy storage and uniform pores of less than 2 nm are the most desired for this application.

## Current centre research in supercapacitors

The research in our centre focuses on the optimisation of carbon porous structure and surface chemistry to obtain high-performing supercapacitors with improved energy densities and high power densities for the potential application in hybrid vehicles. We are also keen to synthesise low-cost carbon materials from agricultural and other waste products for application in supercapacitors.

## **Applications**

Supercapacitors have an ever expanding array of applications in portable electronics. They have already been used in the following applications:

- Digital cameras
- Portable computers
- Wireless devices
- Mobile phones

Importantly, they are the key component of a hybrid-electric vehicle when used in combination with a fuel cell or battery. The supercapacitor provides the energy boost when accelerating or driving uphill, while the energy can be restored quickly during breaking.