



# CAPACITOR SCIENCES

Transforming Energy Storage

# Capacitor Sciences

## Capacitive Energy Storage to Replace Batteries

**Problem:** Li Ion batteries are expensive, flammable and low capacity

**Solution:** Capacitive energy cells that are low cost, safe and high capacity



Hoverboard battery fire



UPS freight airliner battery fire

# Capacitor Sciences Proposition – Surpassing Li-Ion

## Capacitive energy storage devices:

- ▶ High energy density, no capacity fading
- ▶ Non-flammable & non-explosive
- ▶ Rapid charge and discharge
- ▶ Low-temperature operation
- ▶ Solid-state, 20+ year lifetime

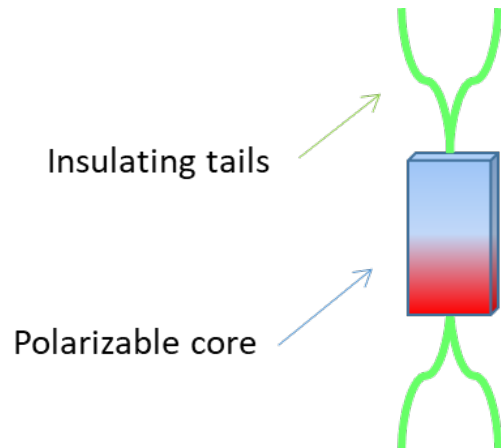


**Energy Storage Cell Goals: 1 kWh/kg Energy Density & 10,000+ Cycles**

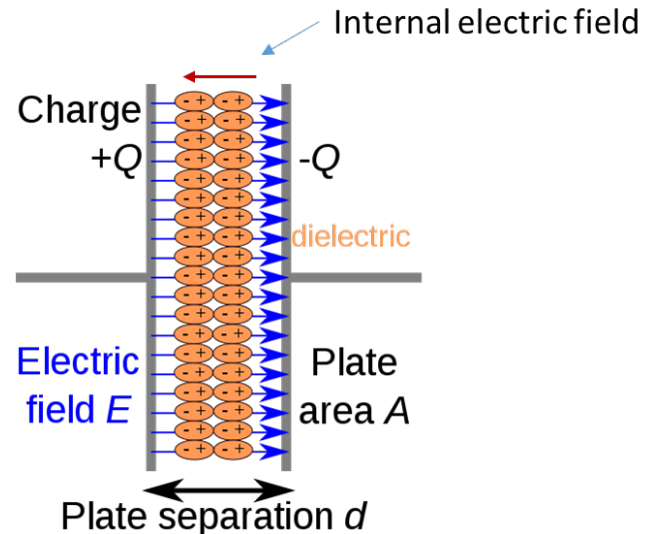
# Dielectrophore Capacitor Fundamentals:

- High Polarizability for High Density Energy Storage
- High Resistivity for Long Duration Energy Storage

Capacitor Sciences' Dielectrophore Molecule



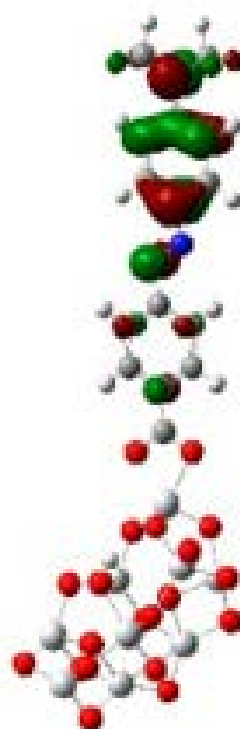
Polarized Molecules Between Electrode Plates



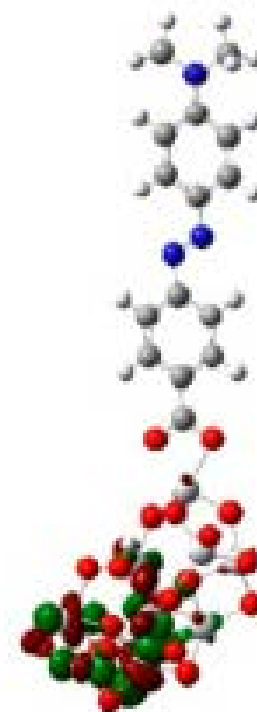
# Capacitor Fundamentals: Polarizability

- Polarizability is Electron Cloud Displacement
- High Polarizability Yields High Energy Density

Electron cloud displacement from HOMO to LUMO



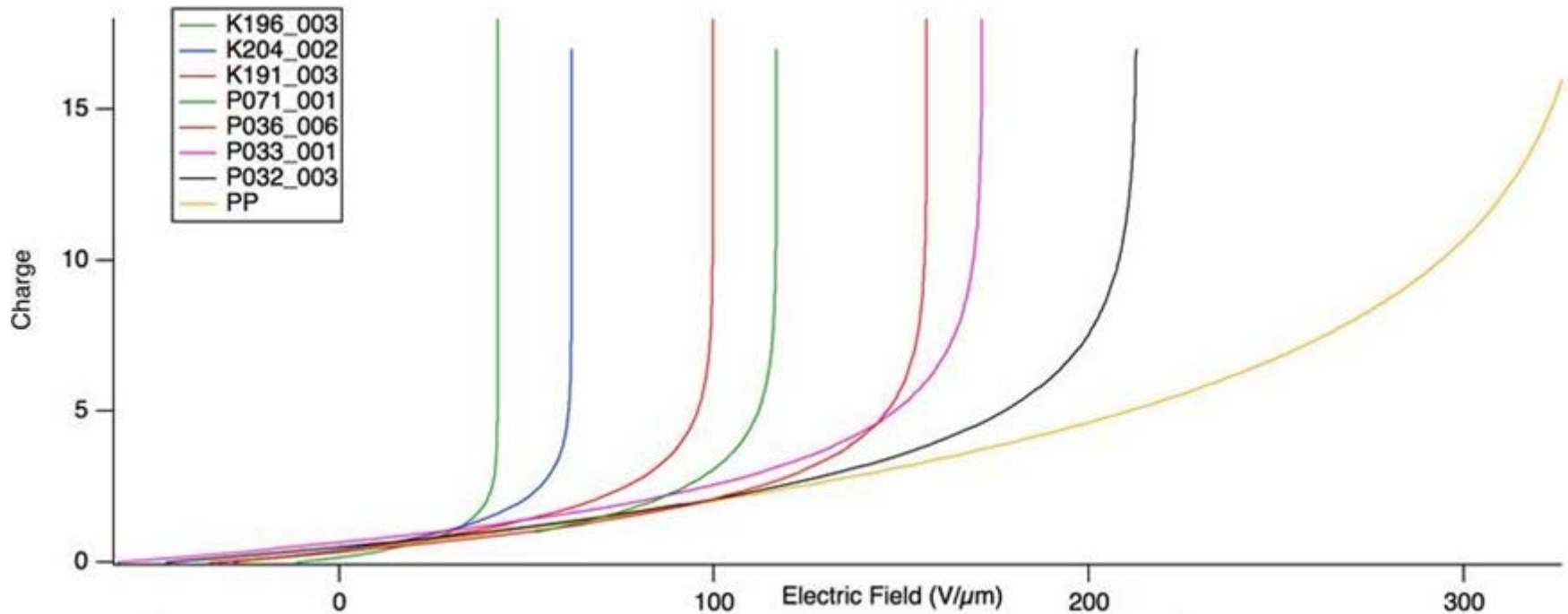
HOMO



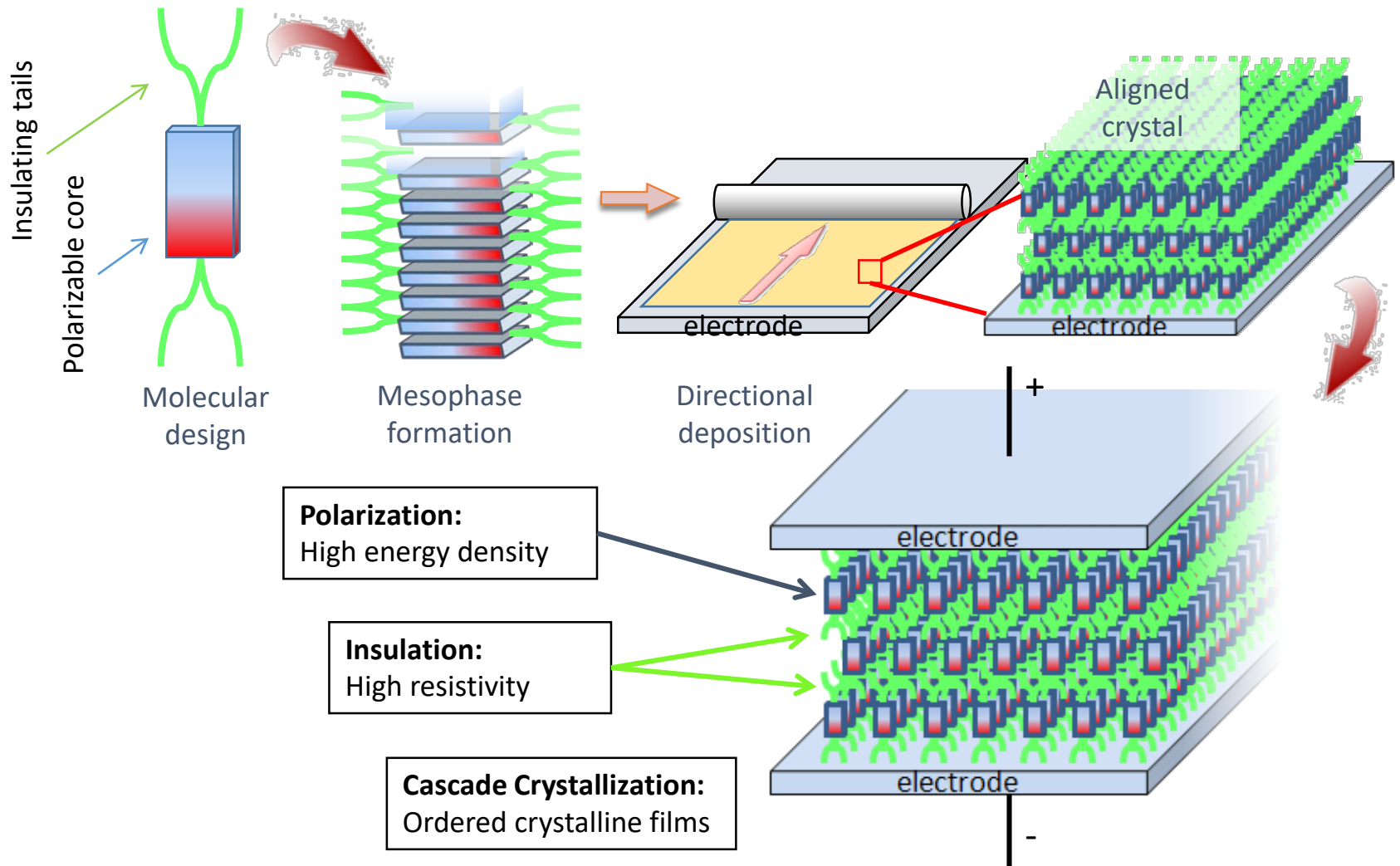
LUMO

# Nonlinear Capacitance

- Voltage Decreases with Increasing Number of Aromatic Rings
- Energy Density Increases with Number of Aromatic Rings (Cell-Level kWh/kg)
- Voltage Remains Constant with Increasing External Electric Field



# Ordered Films: Polarizability & Resistivity



# Energy Density Approaching Fossil Fuels

## Experimental Results

- Energy Density: Breakdown loading is 0.75 kWh/kg to 2.5 kWh/kg (Cell-Level)
- Resistivity:  $10^{14}$  to  $10^{16}$   $\Omega$ -cm,  $10^{15}$   $\Omega$ -cm required to retain 90% of energy for 100 days



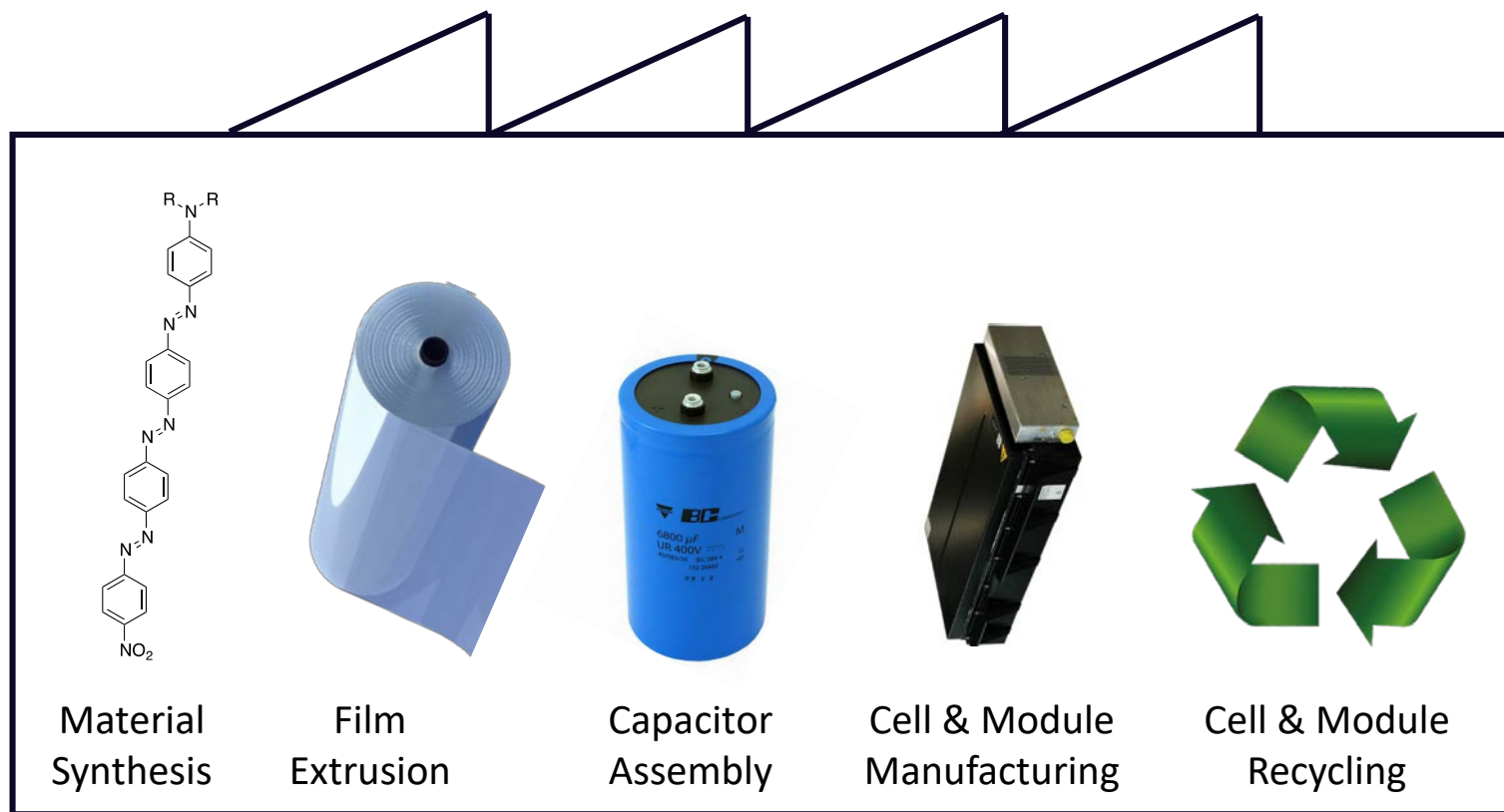


# Target Applications



# 10 GWh/Year Factories

- 100kWh Per Electric Vehicle
- 10 GWh Supports Manufacturing of 100,000 Electric Vehicles Per Year
- 1,000 Factories Producing 10 GWh Per Year for Global EV Demand



wolfgang.mack@capacitorsciences.com

1530 O'Brien Drive, Suite B  
Menlo Park, CA 94025