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Why nanomaterials?

- Global economic development and prosperity over past and present century built on cheap and abundant fossil fuel.

<table>
<thead>
<tr>
<th>Fossil Fuel</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Petroleum</td>
<td>39%</td>
</tr>
<tr>
<td>Natural gas</td>
<td>24%</td>
</tr>
<tr>
<td>Coal</td>
<td>23%</td>
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</tbody>
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There is limited amount of fossil fuel ..........Non-Renewable

The world’s hunger for energy is rapidly increasing while we at the same time face dwindling resources.
A major technological challenge for human race in 21st century is the transition from fossil-fuel-based energy economy to renewable (sustainable) energy one.

“By some estimates there is an average of 2% annual growth in global oil demand along with a 3% natural decline in production from existing reserves” ....Dick Cheney
• After the production peak, as supplies decline and prices rise, with rising populations and continued industrial development the demand for oil will reach a critical stage
Alternative sources.......Renewable

- Solar
- Wind

Renewable energy options great BUT intermittent.

Need to harness their energies when sun or wind are/is on.

By devising efficient energy storage technologies.

Common examples;

- Electrostatic capacitors
- Electrochemical capacitors (Supercapacitors)
- Batteries
- Fuel cells
Energy storage devices

Hence, Nanostructured electrode materials for lithium-ion batteries & electrochemical capacitors
Supercapacitor – Energy storage device

Architecture

Electrode

Electrolyte

Separator

Electric double layer
Synthesis of functionalised graphene oxide

6g Aniline

3g Graphene oxide

Sonication

4hrs

Filtration and drying for 24Hr at 60°C

Aniline functionalised graphene oxide yield 0.2738
Deposition of Platinum nanoparticles on F-GO

0.1004 g of F-go

2.5 ml of $K_2PtCl_6$
40 ml of ethylene glycol as reductant

1. Sonication 4 hrs
2. Heat on reflux to 100° C for 24 hrs

Dried for 24 hrs

Filtration and wash with water

Yield 0.1067 g
SEM of f-GO-Pt
TEM of f-GO-Pt
Synthesis of PANi nanocomposite

1. Add to 100 mL HCl
2. Sonicated

Transfer to ice-bath & Aniline added

(NH₄)S₂O₄

Stir

Left standing for in ice-bath

Aged

Supernatant discarded, ppt washed, dried

TaO₂ + PSSA

TaO₂-PANi-PSSA

Electrode material
TEM of TaO$_2$-PANI-PSSA
SEM image of Ta$_2$O-PANi-PSSA
TEM picture of NiO
TEM of TaO-NiO-Mn$_3$O$_4$
HRTEM of TaO$_2$-NiO-PANi-PSSA
NiO$_2$-TaO$_2$-PANi-PSSA
HRTEM of TaO-Mn$_2$O$_3$-PANI-PSSA
TEM of TaO-NiO-Mn$_3$O$_4$-PANI-PSSA
SEM of CuO-NiO-PANi
PANi-GO-Cu-Cr