Surface Modification of TiO_2 NPs for Improving DSC Performance

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Motivation

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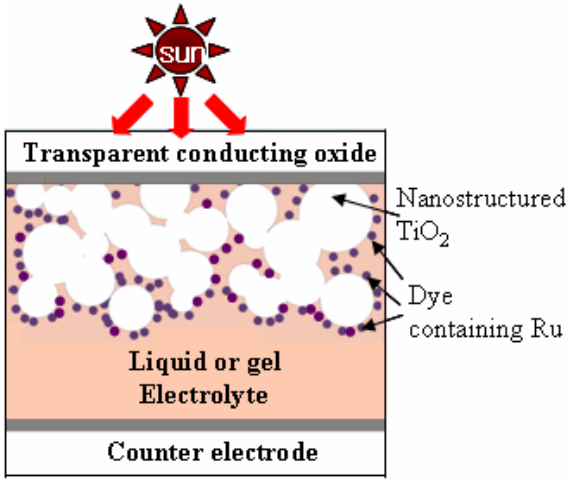
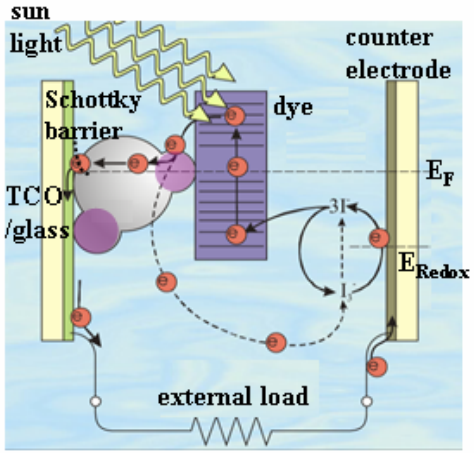
❖ Dye-sensitized solar cells (DSC)

◆ DSCs: a promising candidate for next-generation solar cell

(low cost/energy saving process, environmental friendly, flexible device)





<Operating sequence of DSSC>

1) Exciting electron of dye by **absorbing solar spectrum**
2) **Electron extraction** at dye-TiO_2 interface
3) **Electron diffusion** through TiO_2 anode
4) **Electron injection** at TiO_2-TCO interface
5) **Current** to counter electrode through an external load
6) **Charge transfer** in electrolyte

◆ Scope of study

- At step 2, requiring more dye adsorption and retardation of back electron transfer
- Study on surface modification of TiO_2 nanoparticles and their solar cell performance

Nanoporous Oxide Coating on TiO_2

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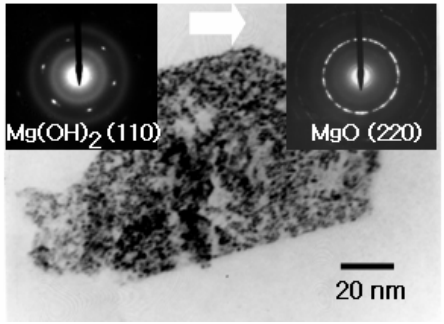
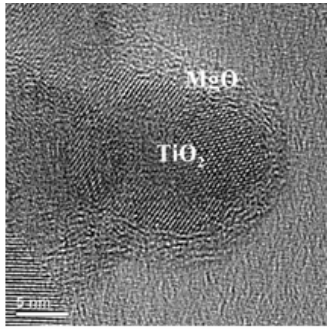
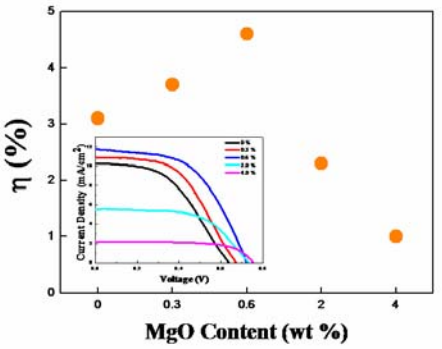
❖ Influence of Nanoporous MgO Layer







H.S. Jung et al, Langmuir *21*, 10332 (2005)

◆ Enhanced solar cell performance

- I_{sc} increases to 11.7 mA/cm^2 from the 10.2 mA/cm^2 of the bare TiO_2.
- V_{oc} and the fill factor (FF) also increase.

◆ Origin of enhanced solar cell performance

- The coating of the MgO nanolayer apparently increases the amount of adsorbed dye molecules (2 times) →
  → **Nanoporous structure of MgO**
- The nanoporous MgO shell reduces back electron reaction with electrolyte
  → **Insulating nature of MgO**
- Increase in dye adsorption (I_{SC} ↑) & retardation of back electron transfer (I_{SC}&V_{OC} ↑)

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Naporous Oxide Coating on TiO_2

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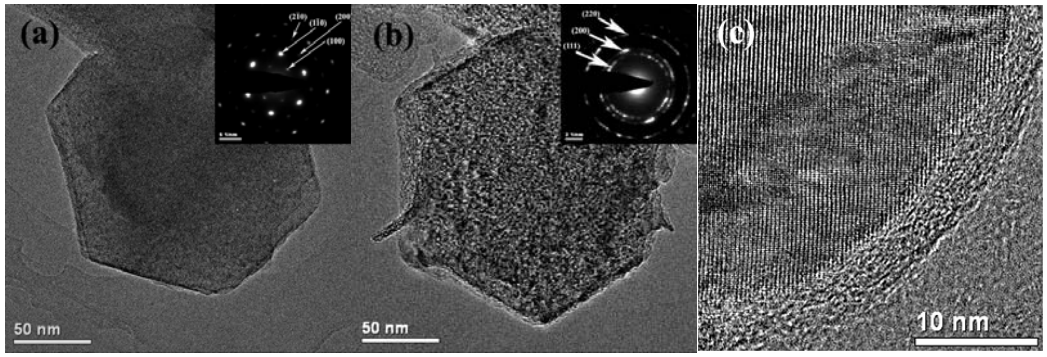
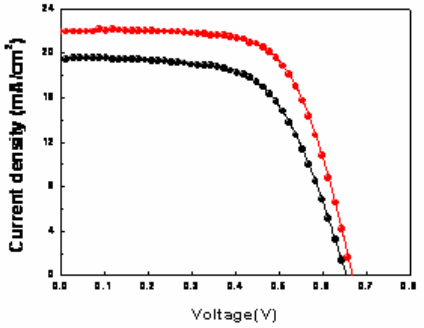
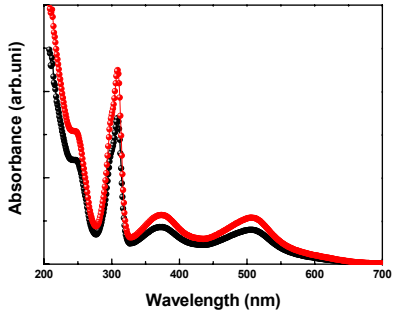
❖ Influence of nanoporous $CaCO_3$ Layer

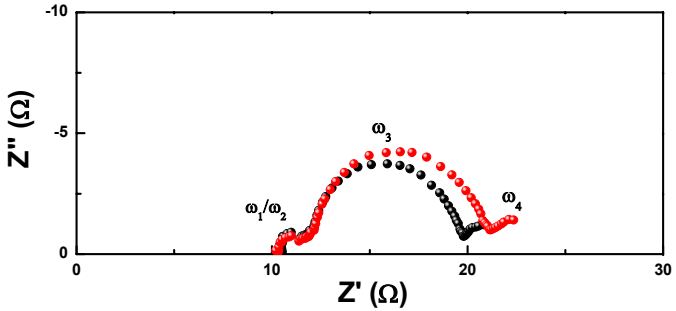




H.S. Jung et al, Submitted to Chem. Mater.

◆ Origin of enhanced solar cell performance





-Increasing the amount of adsorbed dye molecules
→ **Nanoporous structure of $CaCO_3$**
Reducing back electron reaction with electrolyte
→ **Insulating nature of $CaCO_3$**

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Current and Future Work

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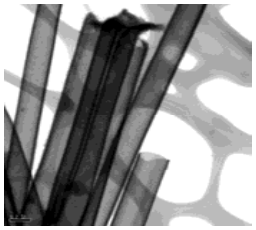
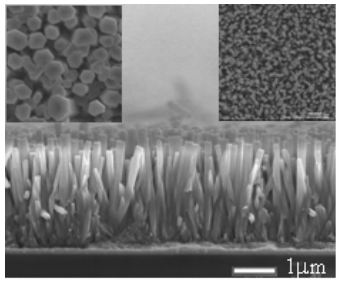
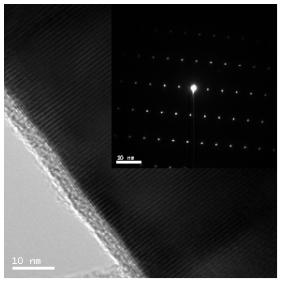
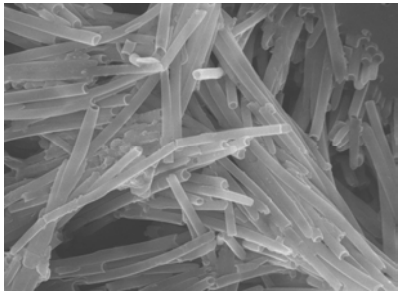
- Research approach : improving the **carrier transport in semiconductor nanoparticles**
  - To synthesize **arrays** of semiconductor oxide **nanwires**.
  - The grain boundaries: **preventing** the transport of carriers via a **scattering** mechanism.
  - To **increase** the **mobility** of carriers in 1-dimensional nanowires by **removing** grain boundaries.
  - To exploit the **ALD** process and the **anodizing** method for arrays of semiconductor nanowires (TiO_2, ZnO)





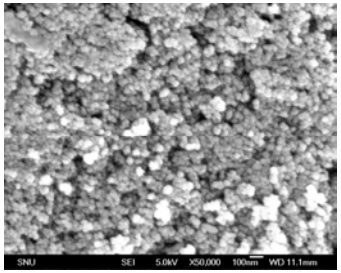


TiO_2 coated ZnO NRA

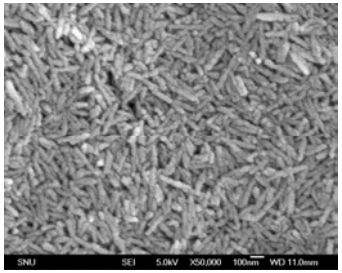


TiO_2 nanotube

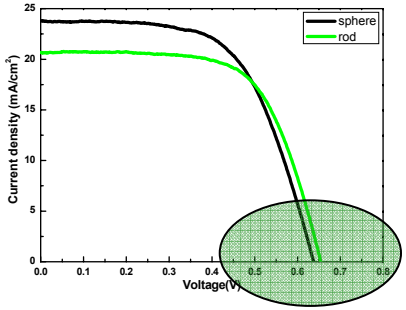
Prof. H. Shin at KMU



Spherical TiO_2 NPs



Elongated TiO_2 NPs



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