Fabrication of Dye Sensitized Solar Cells Using Fe-, Mn- and Co-oxyhydroxide nanocrystals in ferritin as the dye

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Renewable energies in the USA

Source: U.S Energy Information Administration (EIA)
Best Research-Cell Efficiencies

Source: http://www.nrel.gov/ncpv/images/efficiency_chart.jpg
Mechanism of Dye Sensitized Solar Cells (DSSCs)

- $\text{TiO}_2|S + \text{hv} \rightarrow \text{TiO}_2|S^*$
- $\text{TiO}_2|S^* \rightarrow \text{TiO}_2|S^+ + e_{cb}$
- $\text{TiO}_2|S^+ + e_{cb} \rightarrow \text{TiO}_2|S$
- $\text{TiO}_2|S^+ + 3/2 I^- \rightarrow \text{TiO}_2|S + 1/2 I_3^-$
- $1/2 I_3^- + e_{(Pt)} \rightarrow 3/2 I^-$
- $I_3^- + 2 e_{cb} \rightarrow 3 I^-$
Why Ferritin?

- Different wavelengths of light can be absorbed using different nanocrystals
- Prevent photo-corrosion in metal oxide semiconductors
- Thermo-stable up to 80°C.
Theoretical Efficiency of Ferritin Based Solar Cells

<table>
<thead>
<tr>
<th>$f_0$ (# Suns)</th>
<th>Operating voltages (V)</th>
<th>Theoretical efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ti, Fe, Co, Mn</td>
<td>1</td>
<td>1.856, 1.680, 1.490, 1.181</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>1.974, 1.798, 1.607, 1.298</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>2.130, 1.954, 1.764, 1.453</td>
</tr>
<tr>
<td>Ti, Fe, Co, Mn, Si</td>
<td>1</td>
<td>1.856, 1.680, 1.490, 1.191, 0.748</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>1.974, 1.798, 1.608, 1.308, 0.864</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>2.130, 1.954, 1.764, 1.464, 1.012</td>
</tr>
<tr>
<td>Ti, Co, Mn, Si</td>
<td>1</td>
<td>1.905, 1.505, 1.251, 0.825 (5.49 total)</td>
</tr>
<tr>
<td>(Current matched)</td>
<td>100</td>
<td>2.024, 1.622, 1.370, 0.944 (5.96 total)</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>2.182, 1.778, 1.527, 1.103 (6.59 total)</td>
</tr>
</tbody>
</table>

Fabrication

1. TiO$_2$ preparation and deposition
2. Ferritin deposition
3. Counter Electrode preparation
4. Assembling the cell and electrolyte injection
First Results

Open circuit voltage measurements of the different DSSCs fabricated. Volume used: 2 mL – Deposition time: 97 hours

Ferritin-Mn open circuit voltage measurement
Challenges

+ Understanding the chemical and physical interactions between ferritin and TiO2
Conclusions & future works:

- Ferritin has been used as an alternative dye for DSSCs
- Increasing open circuit voltage due to ferritin
- Need to investigate physical and chemical interactions between ferritin and titanium dioxide
- Start to develop multilayer DSSCs