Solar-to-Hydrogen Energy Conversion

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Why solar energy?

~14 TW (now) → ~40-50 TW (by 2100)

Fossil-fuels economy

“Green” economy
Why solar energy?

~14 TW (now) → ~40-50 TW (by 2100)

120,000 TW → ~50,000 TW

~80,000 TW absorbed

600 TW practical

Capture  Conversion  Storage
Why solar energy?

Solar Cells

Direct solar-to-electrical conversion

~0.16% coverage at ~10% efficiency = 20 TW

Works only at daylight
Solar water splitting

Direct solar-to-hydrogen conversion

Water: $\text{H}_2\text{O}$

$\Delta G^o = +273.18 \text{ kJ mol}^{-1}$

DOE report, 2008
Materials for solar water splitting

**Oxides**

Titanium Dioxide ($\text{TiO}_2$),
Zink Oxide ($\text{ZnO}$)

Band gap $> 3\text{eV}$

**Oxynitrides**

Lanthanum Titanium oxinitride ($\text{LaTiO}_2\text{N}$)

Need band gap $< 3\text{eV}$

Optimization needed
Six barriers to efficient solar water splitting

1) Loss due to band gap

2,3) Loss due to inadequate conduction band or valence band driving force

4) Loss due to transport / absorption depth limitations

5) Loss due to kinetic barriers to $H_2$ production

6) Loss due to kinetic barriers to $O_2$ production

$2H_2O + 4h^+ \rightarrow O_2 + 4H^+$

$2H^+ + 2e^- \rightarrow H_2$

$2H_2O \rightarrow 2 O_2 + 4H^+$
Lanthanum Titanium Oxynitride (LaTiO$_2$N)

- Obtained LaTiO$_2$N thin films on insulating and conducting custom-made oxide crystals
- Studied optical properties and influence of microstructure of the films on the PEC activity

A - amorphous La-Ti-O-N
B - single crystal LaTiO$_2$N
C - interfacial layer
Acknowledgements

Dr. Peter Khalifah

Group members and collaborators

DOE Solar Photochemistry (Grant No. DE-FG02-11ER16266) at Stony Brook University and Contract DE-AC02-98CH10886 with the U.S. Department of Energy. Center for Functional Nanomaterials, which is supported by the Department of Energy under grant DE-AC02-98CH10886.

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