Conversion of CO_2 into Fuels

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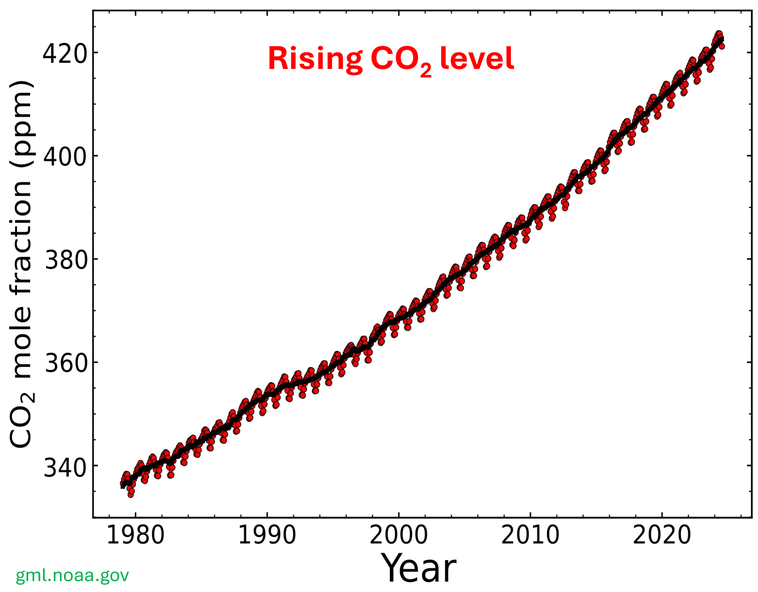
Rise in CO_2 Emission



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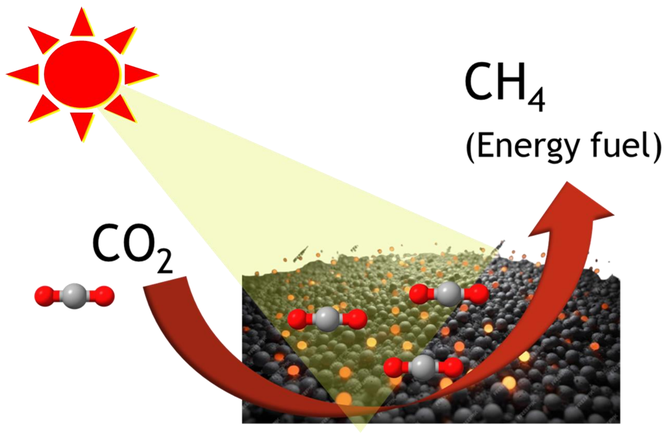
- Consequences:
  - Climate change
  - Ecosystem disruption
  - Agriculture
  - Human health risk
  - Economic Impact

How About Converting CO_2 into fuel?

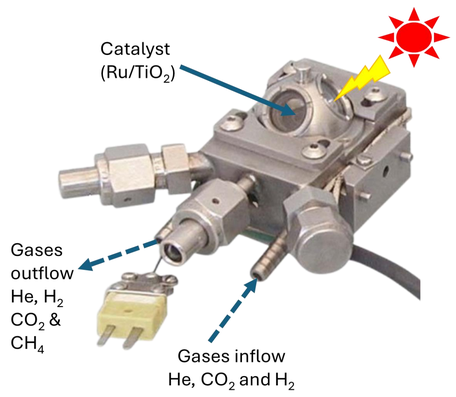
- Approach → Photothermal: use solar energy for CO_2 reduction



- Synergy of sunlight and heat make this conversion energy-efficient

Methodology

- Catalyst (Ru/TiO_2 nanoparticles):
  - Absorb sunlight
  - Convert sunlight to chemical energy
  - Large surface area
- Energy: sunlight (light + heat)
- Gases: CO_2, H_2, He



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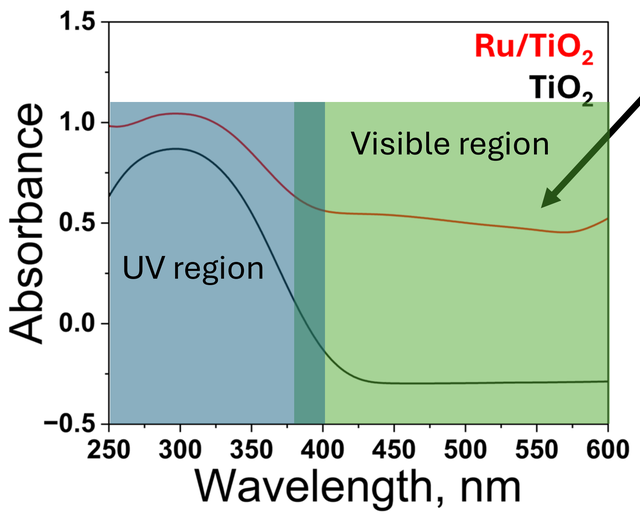
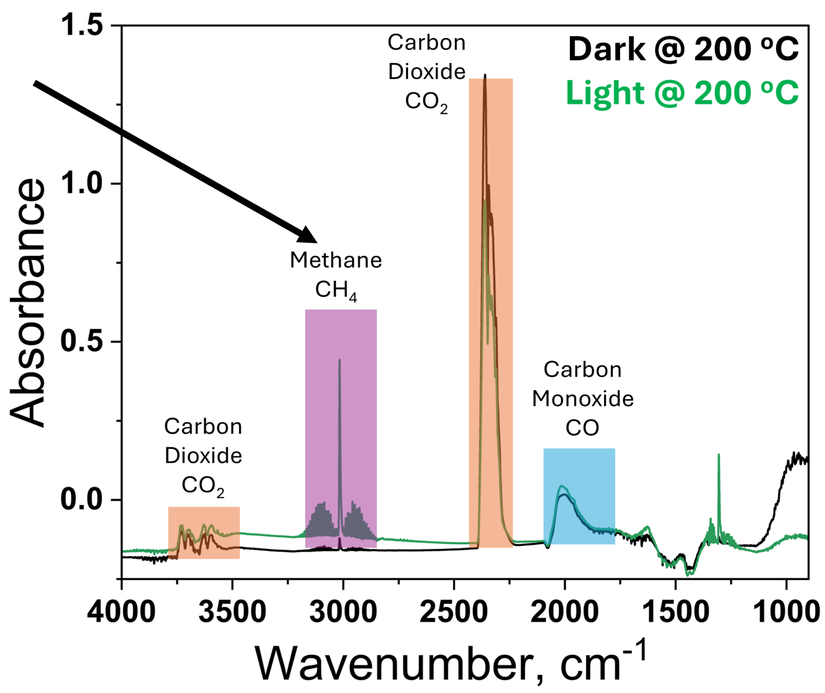
CO_2 Conversion on Ru/TiO_2 Surface



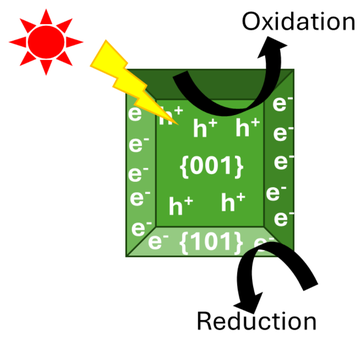
- Deposition of Ru on TiO_2 surface enhances its visible light absorption
- Methane formation under light irradiation

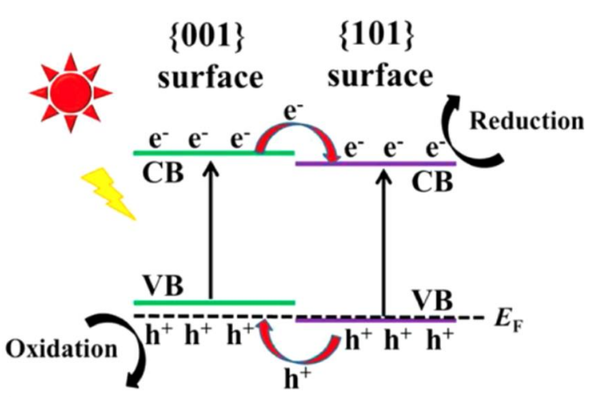


Conversion of CO_2 to CH_4 is two step process:

1. $CO_2 + H_2 \rightarrow CO + H_2O$
2. $CO + 3H_2 \rightarrow CH_4 + H_2O$

Current Research

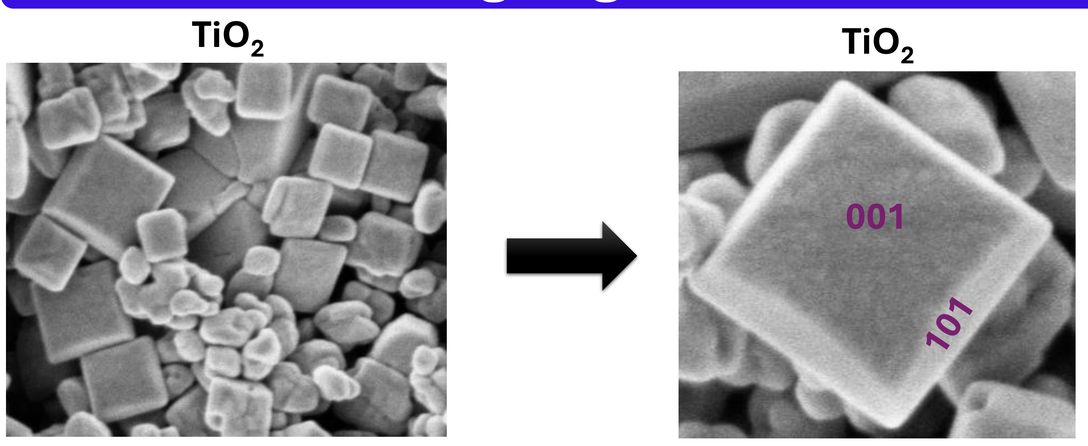




- Under UV light electron migrate from {001} facet to {101} facet
- {101} facet act as reduction site
- Efficient CO_2 conversion at 101 facet

Yu, J., et. al., J. Am. Chem. Soc. 2014, 136(25), 8839−8842

Ongoing Work



Benefits of This Method

- Removes CO_2 from atmosphere
- Sustainable fuel production
- Support climate targets

Scalability of Photothermal CO_2 Reduction

- Efficiency 10%, low for industrial application
- Durability of material
- Higher carbon products like gasoline, natural gas, etc.

Zhou, Y. et. al., Energy Conversion and Management, 2023, 291, 117246

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