Approaches to Light-Driven CO\textsubscript{2} Reduction
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Abstract:
Two approaches to light driven conversion of carbon dioxide to C\textsubscript{2}+ products are shown.

- In a process analogous to natural photosynthesis, solar-driven reduction of carbon dioxide to hydrocarbon and oxygenate products is demonstrated with an overall efficiency exceeding 5%.
- Solar-driven photocathode converts carbon dioxide to C\textsubscript{2} and C\textsubscript{3} products and has 20 day stability.

Introduction
Solar to chemical energy conversion could provide an alternative to mankind’s unsustainable use of fossil fuels. One promising approach is the electrochemical reduction of CO\textsubscript{2} into chemical products, in particular hydrocarbons and oxygenates which are formed by multi-electron transfer reactions. Widespread adoption of such a technology could slow the rate of carbon dioxide emissions into the atmosphere by replacing chemicals obtained from oil with sustainably generated alternatives.

Efficient Solar-Driven Electrochemical CO\textsubscript{2} Reduction to Fuels and Chemical Building Blocks

Scientific Achievement
Solar-driven CO\textsubscript{2} reduction system generates hydrocarbon and oxygenate products with an efficiency far higher than natural photosynthesis.

Significance and Impact
Practical demonstration of direct, solar-driven conversion of CO\textsubscript{2} to valuable products is a major step towards providing an alternative to mankind’s unsustainable use of fossil fuels.

Research Details
- Bimetallic “nanocoral” CO\textsubscript{2} reduction cathode produces ethanol and ethylene with high energetic efficiency
- 3-4% overall efficiency for the production of C\textsubscript{2} hydrocarbons and oxygenates over the course of a solar day using commercial silicon solar cells
- Over 5% efficiency with tandem solar cell

Photocathode converts carbon dioxide to C\textsubscript{2}+ products

Scientific Achievement
Coupling photocathode to halide perovskite solar cells produces C\textsubscript{2}+ products with an efficiency greater than that of photosynthesis.

Significance and Impact
Integration of light absorbers with selective catalysts will enable modular design of solar-driven CO\textsubscript{2} reduction systems.

Research Details
- JCAP-developed selective CO\textsubscript{2} reduction catalyst integrated with Si light absorber
- Engineered interface layers collect charge selectively and suppress recombination
- 20 day operation demonstrated with regeneration of catalyst

Outlook
These studies provide a clear framework for the future advancement of efficient solar-driven CO\textsubscript{2} reduction devices. Future work will concentrate on improving selectivity and longevity and in making performing CO\textsubscript{2} conversion directly with light.

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References