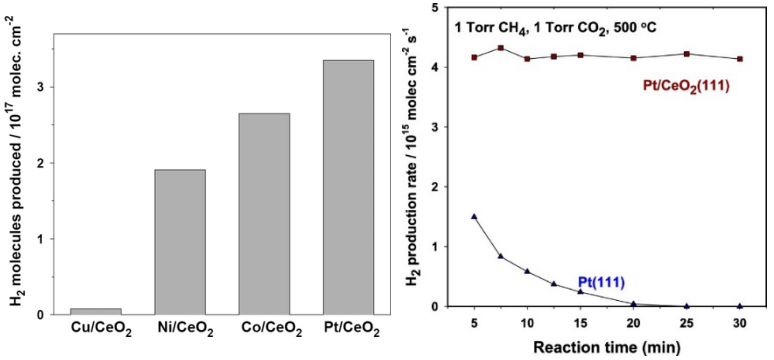
Transforming Pt-CeO_2 interfaces into Active and Stable Catalysts for the Conversion of Carbon Dioxide and Methane

Scientific Achievement

Scientists developed active catalysts for conversion of carbon dioxide and methane to syngas (CO/H_2), using Pt-CeO_2 interfaces with small Pt clusters activated by strong metal-support interactions with ceria.



Pt/CeO_2(111) shows stable activity: higher than other M-CeO_2 surfaces (left), and without deactivation seen for Pt(111) (right)

Significance and Impact

The reaction of CO_2 and CH_4 to produce syngas (methane dry reforming, MDR) converts two greenhouse gases to chemical intermediates for sustainable fuel production but requires better catalysts. Here, strong metal-support interactions in Pt-CeO_2 interfaces activate both CO_2 and CH_4 reactants for MDR at moderate temperature (500 C). Pt-CeO_2 has higher activity and selectivity than other M-CeO_2 (M= Ni, Co, Fe, Cu) surfaces and avoids C deactivation that is a limitation of bulk platinum surfaces.

Research Detail

- Experimental studies characterized systems by combined in-situ/operando methods (AP-XPS, XRD, XAFS)
- Studies identified important role of an active Pt-CeO_{2-x} interface where both oxide and metal are involved, and oxide-metal synergy is critical for activity and stability
- Reactor powder catalyst studies (0.5 wt% Pt/CeO_2) confirmed stable activity consistent with models

Feng Zhang, Ramón A. Gutiérrez, Pablo G. Lustemberg, Zongyuan Liu, Ning Rui, Tianpin Wu, Pedro J. Ramírez, Wenqian Xu, Hicham Idriss, M. Verónica Ganduglia-Pirovano, Sanjaya D. Senanayake, and José A. Rodriguez, ACS Catalysis, 11 (2021) 1613-1623

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Work was performed at Brookhaven National Laboratory

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