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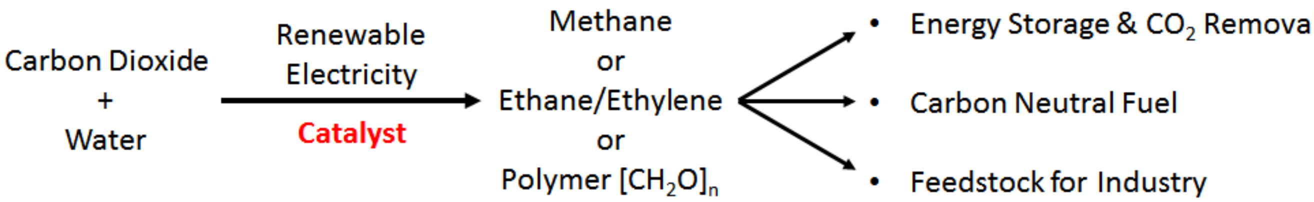
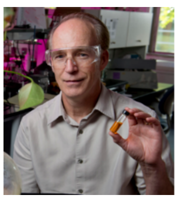
A New Catalyst for Generation of Carbon Feedstocks & Fuels from CO_2



Rutgers co-inventors: Karin Calvinho, Anders B. Laursen, Ph.D, Martha Greenblatt, Ph.D., and G. Charles Dismukes, Ph.D.



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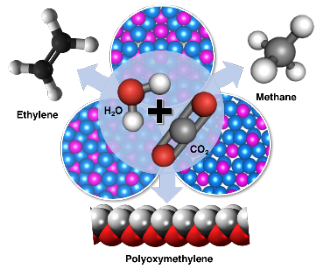

Transition metal phosphides catalyze the reduction of CO_2 to gaseous C1, C2 hydrocarbons and solid $[CH_2O]_n$ with no (toxic) CO formation. They use lower electrical potential than state of the art catalysts (Cu, SnO_2, In_2O_3) and require no process heat or pressure (ambient process).

Intellectual Property Status: US Patent #8,932,977

Innovation Summary: Development of a carbon dioxide (CO_2) reduction catalyst to selectively generate valuable hydrocarbons for fuel or chemical feedstocks for production has long been an unmet need preventing global development of carbon neutral technologies. Researchers at Rutgers University have "designed" transition metal phosphide catalysts to meet these needs. These replace unselective, high temperature catalysts with high efficiency electro-catalysts that use electricity and operate at ambient temperature. Either fossil or renewable electricity can be used for power. Using the latter power sources, the process can be fully sustainable and carbon neutral technology.

Transition metal phosphides and doped derivatives form distinct crystalline structure types, enabling selection of chemical reactivity towards desired products including high molecular weight solid polymers. Selecting the catalyst's elemental composition and crystal structure allows tuning of the chemical, physical and electrical properties to achieve the best match with desired product and application.

Market Applications: Renewable feedstocks and fuels; methane and ethylene production for the chemical industry; CO_2 gas to solids via polymeric $[CH_2O]n$ ($3>n>100$), CO_2 emissions recycling/mitigation, electrical energy storage;

Advantages:

- Lower operating costs, higher selectivity compared to pressurized thermal reactors
- Earth abundant materials at lower costs than copper catalysts
- On-demand source of methane/ethylene
- Fossil CO_2 utilization (grid) or fossil displacement (renewable)
- Inherently sustainable and globally scalable

Potential Social and Economic Impact: This technology has the potential to be a direct alternative to fossil raw materials (crude oil, coal, and natural gas) as a source for chemical feedstocks and energy storage.

- According to data published by the US Energy Information Administration, the 2013 value of shipments of organic bulk chemicals was estimated to be $135 billion in the US[1]
- The global oil and gas exploration and production industry is expected to generate revenues of $2.0 trillion in 2016 alone[2]

Carbon neutral synthetic fuels resulting from this technology will not need the expensive and environmentally impactful fossil fuel supply chain (mining/drilling, pipelines/tankers, refineries). Fuel could be made on demand and at strategic locations near hubs. Carbon chemical feedstocks can be tailor-made and would not be the result of the inefficient processing of raw fossil materials.

Next R&D Steps:

- Screen best catalyst compositions and crystalline structures for selected products and key industrial uses
- Develop industrial scale production methods to be able to produce the catalysts to meet market demand

1 Perl, K. (2015, May 29). U.S. Energy Information Administration - EIA - Independent Statistics and Analysis. Retrieved September 23, 2016, from https://www.eia.gov/todayinenergy/detail.cfm?id=21432

2 (2016, May). Global Oil & Gas Exploration & Production. IBISWorld Industry Report.