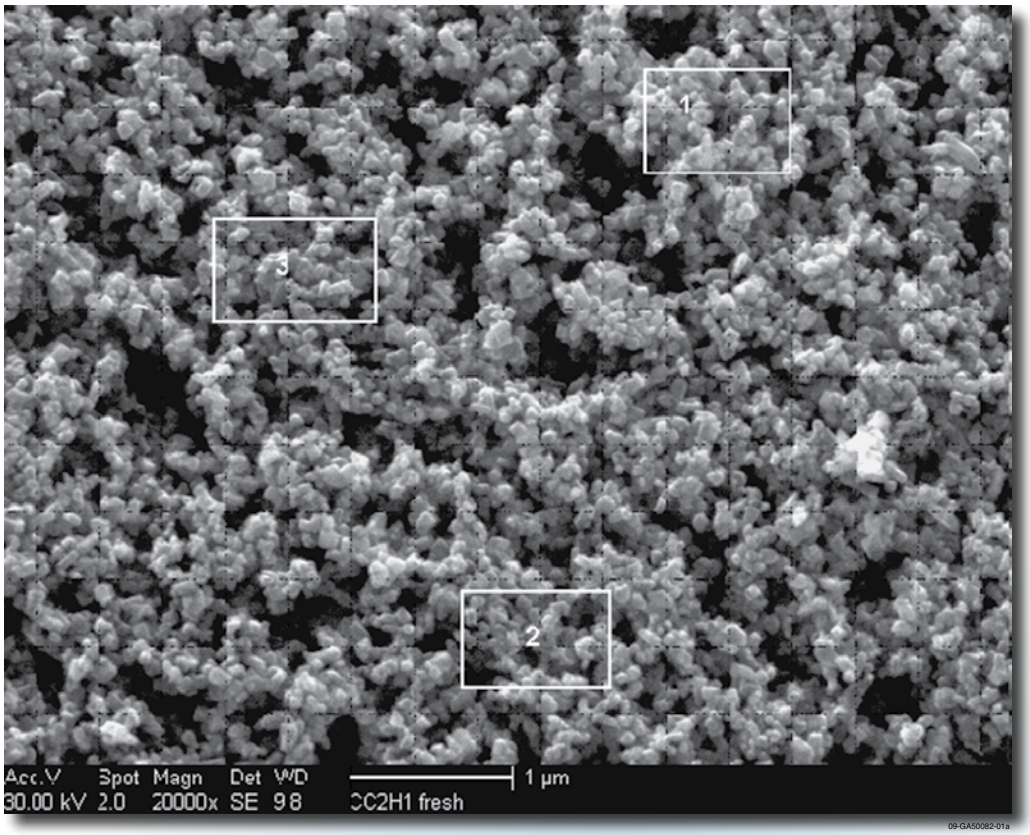


*Copper-oxide/zinc-oxide materials synthesized by a proprietary INL process produced higher surface area than either of the zinc-oxide or copper-oxide components.*

# Producing Higher Alcohols

## *Multi-functional Heterogeneous Syngas Catalysts for the Production of Higher Alcohols*

Idaho National Laboratory has produced multi-functional catalysts for CO and $CO_2$ hydrogenation to liquid fuels. Catalysts have high activity and can be synthesized to have preferential selectivity to produce higher molecular weight mixed alcohols including ethanol, propanols and butanols in a single process.

### *Background*

A base catalyst was developed and tested for methanol production. The catalyst is produced by the hydrothermal synthesis of copper and zinc oxide precursor compounds. The synthesis product is dried in an oven at moderate temperatures, calcined and then reduced in hydrogen to produce nano-scale copper metal on zinc oxide. In reaction studies using carbon dioxide and hydrogen as the feedstock, methanol production rates approaching twice that of a commercial synthesis gas to methanol catalysts were achieved under the same set of conditions.

By modifying the base catalyst with the addition of other metals and promoters, mixed higher molecular weight alcohols have been produced. The most recent catalyst composition produced an alcohol product with higher molecular weight mixed alcohol (ethanol to butanols) composition of 77.4 percent, limiting methanol to less than 23 percent.

The catalysts have been developed and tested under bench scale conditions. Results from initial tests indicate significantly higher catalyst activity as compared to a commercially available methanol synthesis catalyst. The catalysts provide a cost-saving synthesis route for the reduction of $CO_2$ to liquid alcohols.

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The Energy of Innovation
Idaho National Laboratory

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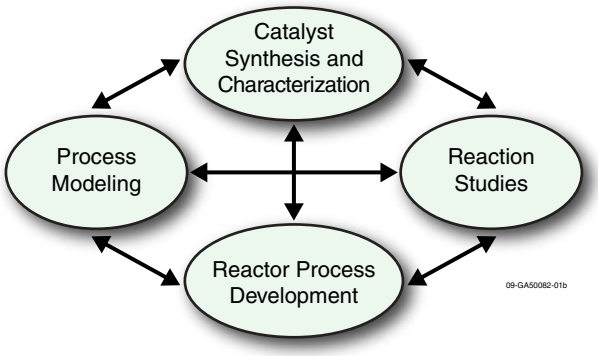
The R&D program currently being carried out is funded by INL and private investment. It incorporates integrated tasks of catalyst synthesis and characterization, reaction studies, reactor process development, and process modeling. This integrated program is designed to expedite development of an economically efficient chemical conversion technology. An initial feasibility study based on results generated from the ASPEN PLUS simulation code suggest that the $CO_2$ to mixed alcohol process can be very profitable, with an internal rate of return calculated to be in excess of 30 percent.



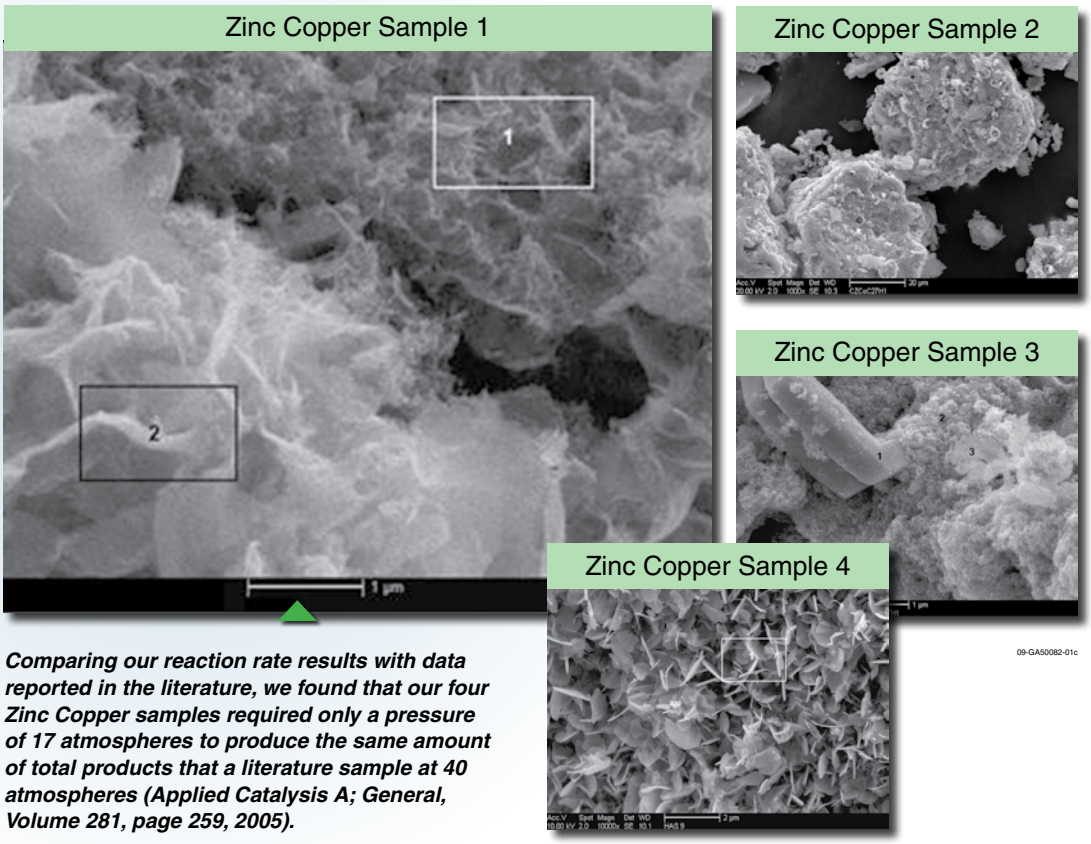

***Integrated Catalyst Process and Development Program.***

### Benefits

This technology could potentially result in an economically viable route to produce alcohols for fuels and chemicals. Further, existing methanol synthesis plants (which are currently running significantly under capacity due to the phase out of MTBE) could potentially be retrofitted to produce mixed alcohols. More importantly, the process offers industrial users a means to recycle $CO_2$.

### Applications

This novel technology could be used by energy and chemical industries as an alternative to Fischer Tropsch synthesis and could infuse new life into the methanol production industry. By replacing methanol catalysts with the new INL catalyst, and retrofitting some of the separation equipment, value-added alternative fuels and chemicals could be produced.




***Comparing our reaction rate results with data reported in the literature, we found that our four Zinc Copper samples required only a pressure of 17 atmospheres to produce the same amount of total products that a literature sample at 40 atmospheres (Applied Catalysis A; General, Volume 281, page 259, 2005).***

## For more information

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