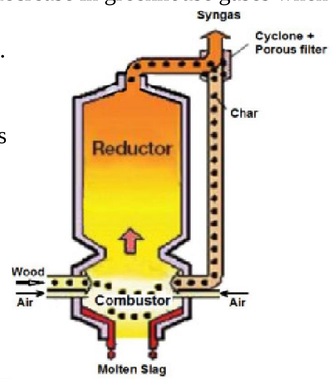
# THE SIGNIFICANCE OF NANOCATALYSTS IN THE PRODUCTION OF SYNGAS

Tyler Brighton and Michael Gresh-Sill

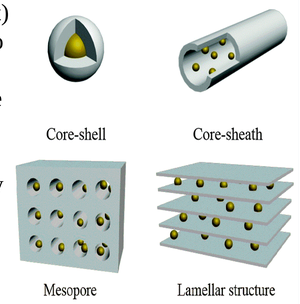
## Syngas Overview

- Syngas is a mixture of CO and $H_2$ that has many applications in both power generation and plastics creation
- Syngas has demonstrated a 45% decrease in greenhouse gases when switching from natural gas use
- Produced by a variety of methods. Currently a gasifier (right) is used to heat biomass and the carbon released from that rises into the reductor where it reacts to form syngas
- Current issues with syngas:
  - Energy generation is currently only viable where syngas is already produced
  - The extreme temperatures required for its production damage catalysts



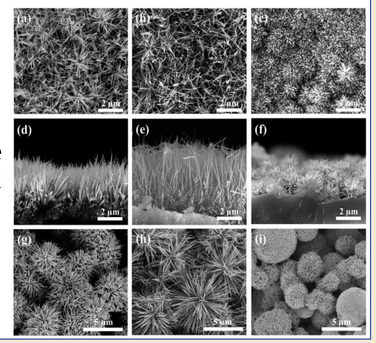

## Nanocatalysts in syngas synthesis

- A nanocatalyst is a compound on the scale of 1^-9 meters that increases the rate of a reaction without being changed itself
- Nanocatalysts in syngas production greatly increase the reactivity of the reaction thereby increasing its efficiency
- When prepared in a nanostructure (right) where the nanoparticles are attached to a larger more stable structure. The nanocatalysts are able to resist damage and continue operating far longer than the conventional catalysts.
- Nanocatalysts cause a higher selectivity towards syngas production because their specific structures only allow for a single reaction to be induced.




## Sustainability of Nanocatalysts

- Current Nanocatalyst can only be produced in small amounts useful for a laboratory setting
- In order to be economically viable and therefore sustainable nanocatalysts must have some method for larger scale use
- A promising method is the monolithic nanoarray (below)
- The nanoarrays are micro structures (10^-6 m) of long lines that stretch perpendicular to a surface. Nanocatalysts can be bound to the surface of the monoliths. This larger structure allows nanocatalysts to be used at a larger scale.
- Currently only simulations exist to demonstrate the use of nanoarrays in syngas synthesis

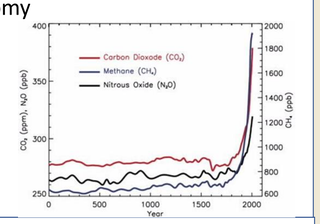



## Economic Impacts and Sustainability

- Because syngas production is a relatively new process, there is a lot of work to be done in terms of harnessing the greatest economic return; however, there are processes today that seek to make syngas an affordable fuel in the present day.
- Underground Coal Gasification (UGG) is one specific process that has shown the potential for positive economic impacts. This process involves gasifying coal reserves underground rather than after extraction. This is especially meaningful because 85% of the world's coal reserves are inaccessible by traditional mining techniques.
- Syngas is an economically feasible stepping stone in the transition from the fossil fuel economy, to a clean energy economy.
- The table to the right shows the relative costs between different methods of synthesis

## Environmental Impacts

- Rising rates, and concentrations of greenhouse gases in the atmosphere has become a major concern for modern society. The graph below indicates just how drastic the spike in emissions is.
- Problems associated with high levels of these types of gases are well documented, however the worlds reliance on fossil fuel energy prevents any real progress on limiting emissions.
- The rise of syngas as an alternative energy has the potential to change the narrative on this issue
- Syngas is unique in the many ways it can be developed and used, nearly all of these ways causing less environmental harm than fossil fuel burning (steam gasification, gas reformation)
- Syngas comes in different chemical compositions, but one major component is hydrogen gas, the combustion of which results in the sole byproduct of water, a not only harmless, but environmentally necessary compound
- A hydrogen fuel economy would pose an environmental impact at only 0.6% the current fossil fuel economy




| Method | US$ GJ$^{-1}$ | US$ kg$^{-1}$ |
|---|---|---|
| Steam methane reforming | 6.45 | 0.78 |
| Coal gasification | 11.71 | 1.41 |
| Hydrocarbon partial oxidation | 8.23 | 0.99 |
| Biomass gasification | 10.31 | 1.24 |
| Biomass pyrolysis | 10.51 | 1.26 |
| Electrolysis | 23.96 | 2.88 |
| Solar electrolysis | 35.75 | 4.29 |
| Photobiological production | 31.36 | 3.77 |