Abstract: The current fossil fuel-dependent economy drives a demand for sustainable energy resources. Although much effort has gone into the production of ethanol, other biofuels, such as butanol, are superior. Butanol has a higher energy content, is less volatile, and is safer to use than ethanol. To develop strains of bacteria that produce high levels of 1-butanol we have introduced the genes coding for a biochemical pathway from Clostridium acetobutylicum into a mutant E. coli strain that produces a high level of NADH. The combination of these chemical pathways is predicted to increase the level of butanol production. Our second project, the Bacterial Etch-a-Sketch, features a complex network of gene expression and repression that enables a lawn of bacteria to respond to 470nm light. This task presents many engineering challenges: the bacteria need to be sensitive enough to respond to a laser pulse, yet selective enough to use in ambient lighting.

Biofuels in Bacteria

Butanol is the Ideal Fuel

Biobutanol is highly similar to gasoline, and is advantageous over other alcohol-based fuels. A simple 85% butanol 15% gasoline mixture can be used in today’s fuel pipelines and internal combustion engines without any modifications to the current fuel system. Butanol is hydrophobic, and has lower tendency to mix with water molecules that may cause fuel contamination. Ethanol poses the issue of water contamination and due to its corrosive properties, can cause damage to the fuel pipelines. Not only is butanol better than other alcohol-based fuels in terms of molecular properties, but it also possess a higher energy content and air-fuel ratio.

Energy and Air-Fuel Ratio of alcohol based fuels

- Methanol
- Ethanol
- Butanol
- Gasoline

Results

We concluded that the mutant strain produced a significantly higher amount of 1-butanol than the wild type. These results were extrapolated from three samples and three hexane extractions from the same culture. This allows us to control for errors in the extraction and measurement, but not for potential variations between independent cultures. The mutant strain of E. coli (CL) produced a yield of 128.1 +/- 5.4 ug/ml/OD; the wild type (OMS alpha) strain of E. coli produced a yield of 93.8 +/- 1.5 ug/ml/OD per cell.

Butanol Production

- pTrc
- pBAD
- plc
- pAC
- adhE
- HBD

Future Prospects

n-butanol Biochemical Pathway

Acetyl-CoA C-acetyltransferase

Input

Light

Output

Color

3-Hydroxybutyril-CoA

Cell growth / Development

Butyryl-CoA

Ctyronyl-CoA

1-Butanol

Acetyl-CoA

References