

## Applications:

- A biological source for producing *cis,cis*-muconic acid and eventually, adipic acid.

## Benefits:

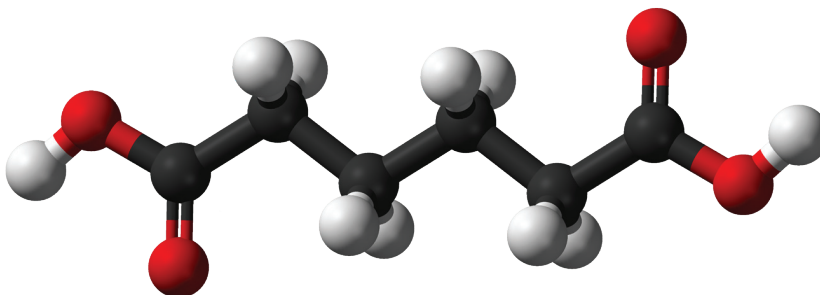
- Reduces dependency on fossil fuels
- Captures CO<sub>2</sub> to produce a valuable specialty chemical

## Contact:

David Hadley  
(505) 667-7539  
dhadley@lanl.gov

tmt-1@lanl.gov

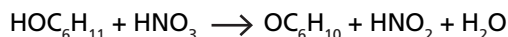
Technology Transfer Division



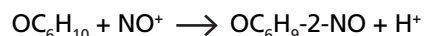
*Adipic acid molecule. Image source: wikipedia.org*

## Summary:

Every year, about 2.2 million metric tons of adipic acid is produced world-wide. This white crystalline powder is mainly used as the precursor for nylon. It is also used in antacids as a means to make them tart, and in medicinal therapeutics in the form of controlled release formulations. As such, from an industrial perspective, it is the most important dicarboxylic acid. Currently adipic acid is produced from a mixture of cyclohexanol and cyclohexanone (both of which are formed from cyclohexane which originates from naphtha benzene) called "KA oil", the abbreviation of "ketone-alcohol oil." The KA oil is oxidized with nitric acid (originating from ammonia from natural gas) to give adipic acid, via a multistep pathway. Early in the reaction the cyclohexanol is converted to the ketone, releasing nitrous acid:



Among its many reactions, the cyclohexanone is nitrosated, setting the stage for the scission of the C-C bond:



A team of Los Alamos researchers is working to engineer a strain of bacteria to produce adipic acid naturally. Using information about enzymes, the "biological workhorses" in cells, and pathways from various organisms, the team is putting all of the necessary components into bacteria for this *in vivo* manufacturing process. This approach will be much more cost effective and provide a non-fossil fuel, CO<sub>2</sub> mitigating source for adipic acid.

## Development Stage:

The necessary enzymatic pathway is being engineered. To date, the host organism can reliably produce *cis,cis*-muconic acid, however the conversion of biologically produced muconic acid to adipic acid occurs non-biologically.

## Intellectual Property Status:

Non-provisional patent application filed 01/11/2011.

## Licensing Status:

Los Alamos is seeking commercial partners to assist with continued R&D and scale up.