MICHIGAN STATE UNIVERSITY

Hazard Reduction and Green Chemistry

Chemistry Department

Ardeshir Azadnia, PhD

Green Chemistry

- **Green chemistry is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances.**

United States Environmental Protection Agency

Presidential Green Chemistry Challenge

1998 Winners

Academic Award

Dr. Karen M. Draths and Professor John W. Frost
Michigan State University

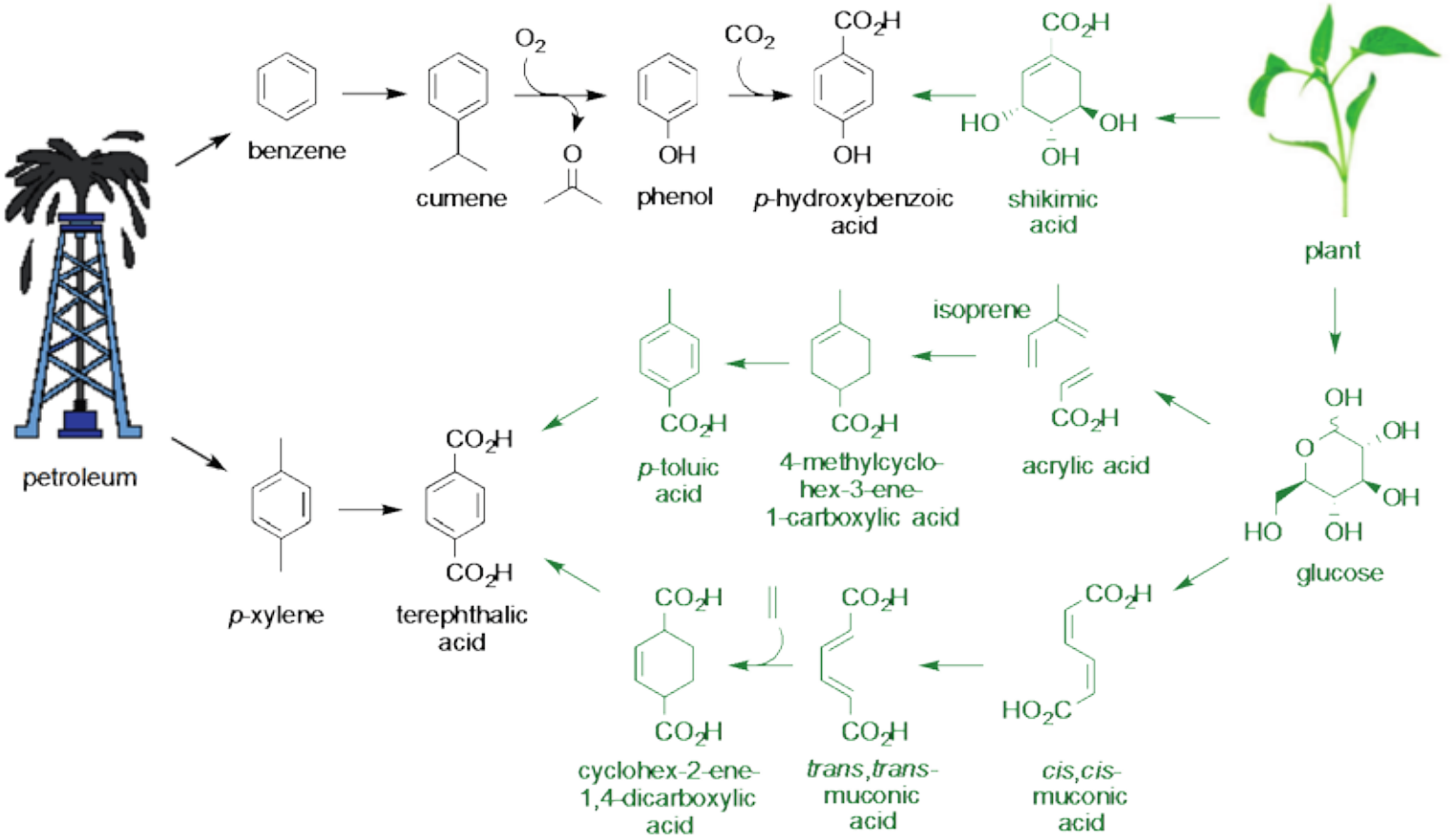
Use of Microbes as Environmentally Benign Synthetic Catalysts

Prof. John W. Frost Dr. Karen M. Draths

Innovation and Benefits

Adipic acid, a building block for nylon, and catechol, a building block for pharmaceuticals and pesticides, are two chemicals of major industrial importance. Using environmentally benign, genetically engineered microbes, Dr. Draths and Professor Frost synthesized adipic acid and catechol from sugars. These two chemicals are traditionally made from benzene, a petroleum product; they can now be made with less risk to human health and the environment.

Green Chemistry at Work



The Frost group is internationally recognized for its research in the field of green chemistry, where group research is directed toward creation of sustainable, and environmentally benign syntheses of a variety of chemicals. These syntheses are catalyzed by genetically engineered microbes and utilize nontoxic starting materials such as glucose derived from renewable feed–stocks such as starch or cellulose. In contrast, current chemical manufacture is dominated by the use of toxic starting materials such as benzene, which is derived from petroleum, a nonrenewable feedstock.

https://migreenchemistry.org/education/michigan-educator-profiles/john-frost/

United States Environmental Protection Agency

Presidential Green Chemistry Challenge

2008 Winners

Academic Award

Professors Robert E. Maleczka, Jr. and Milton R. Smith, III
Michigan State University

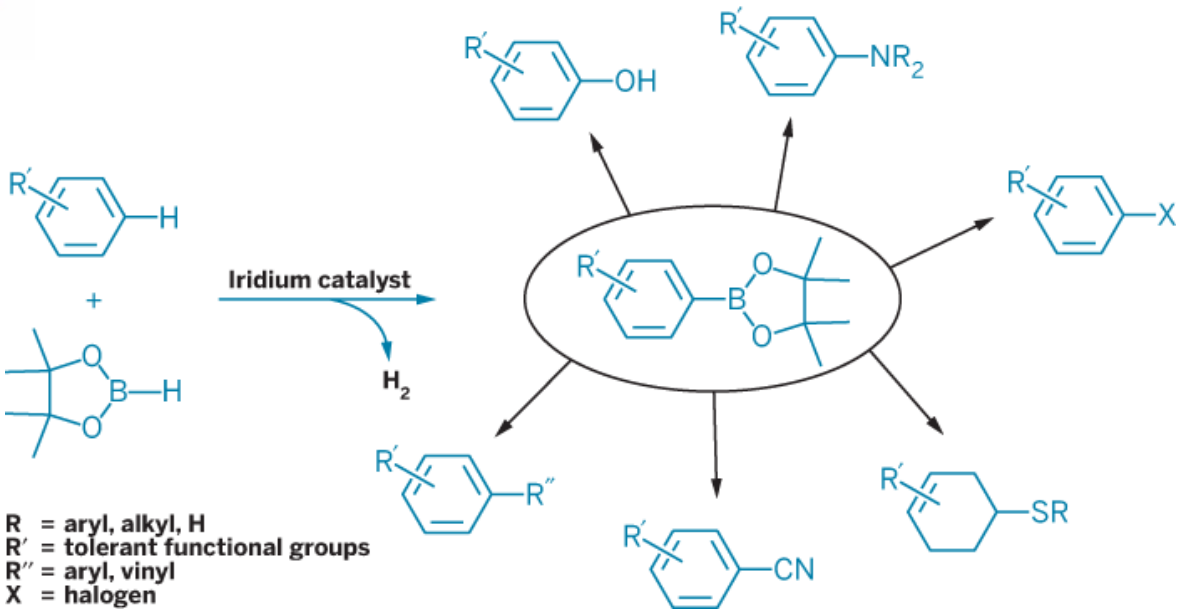
Green Chemistry for Preparing Boronic Esters

Prof. Mitch R. Smith Prof. Rob E. Maleczka

Innovation and Benefits

One way to build complex molecules, such as pharmaceuticals and pesticides, is with a Suzuki "coupling" reaction. This versatile coupling reaction requires precursors with a carbon–boron bond. Making these precursors, however, typically requires harsh conditions and generates significant amounts of hazardous waste. Professors Maleczka and Smith developed a new catalytic method to make these compounds under mild conditions and with minimal waste and hazard. Their discovery allows the rapid, green manufacture of chemical building blocks, including some that had been commercially unavailable or environmentally unattractive.

Cleaner Couplings



"Chemistry professors Robert E. Maleczka Jr. and Milton R. Smith III of Michigan State University received a 2008 Presidential Green Chemistry Challenge Award for their work to improve C–H activation/C–C coupling reactions, one of the most common reactions in organic synthesis. The key advance is an environmentally friendlier iridium-catalyzed reaction to prepare the required boronic ester intermediate that avoids the halogenated precursor traditionally used. The boronic ester subsequently is used to create an array of compounds in one-pot palladium-catalyzed reactions under mild conditions."

Chem. Engin. News 2008, 86(33), 59-68

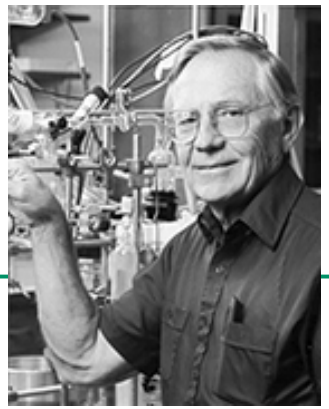
United States Environmental Protection Agency

Presidential Green Chemistry Challenge

SiGNa™

2008 Winners

Small Business Award



Prof. James Dye

Prof. Robert H. Grubbs

SiGNa Chemistry, Inc.

New Stabilized Alkali Metals for Safer, Sustainable Syntheses

Innovation and Benefits

Alkali metals, such as sodium and lithium, are powerful tools in synthetic chemistry because they are highly reactive. However, unless they are handled very carefully, their reactivity also makes them both flammable and explosive. SiGNa Chemistry developed a way to stabilize these metals by encapsulating them within porous, sand-like powders, while maintaining their usefulness in synthetic reactions. The stabilized metals are much safer to store, transport, and handle. They may also be useful for removing sulfur from fuels, storing hydrogen, and remediating a variety of hazardous wastes.

Taming Sodium

"Pure alkali metals are violently reactive and have historically been hazardous to use and store, limiting their use as reducing agents and catalysts. Researchers at SiGNa Chemistry, in New York City, have worked around the safety issue by encapsulating alkali metals in silica or alumina to form free-flowing powders (shown) that are easy to prepare and handle. The powders are being used in a range of pharmaceutical and petrochemical processes. The materials also react with water to produce hydrogen in quantities needed for fuel cells and are amenable to environmental remediation of toxic chemicals. The technology received a 2008 Presidential Green Chemistry Challenge Award."

Chem. Engin. News 2008, 86(33), 59-68

Microscale


CCI
Ether
ACS Grade
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ACS Grade
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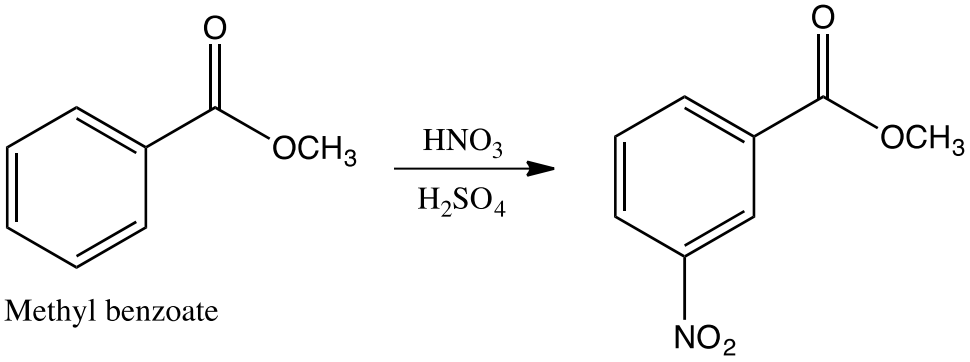
Chemical Prices

Item	Amount	2000-2001	2012 Prices	% Increase
Methyl benzoate	3 K	$52.30	$114.50	119
Ether	6X1 L	$134	$358	167
Acetone	4X2.5 L	$93.40	$337.50	261

Reducing the Purchase of Chemicals For Experiments

Week 8

Nitration of methyl benzoate



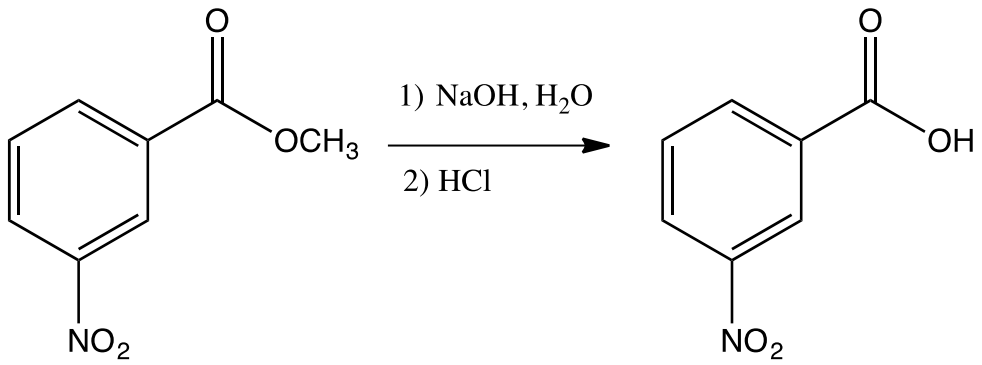
Methyl benzoate

Methyl 3-nitrobenzoate

Reducing the Purchase of Chemicals For Experiments

Week 9

Hydrolysis of methyl 3-nitrobenzoate



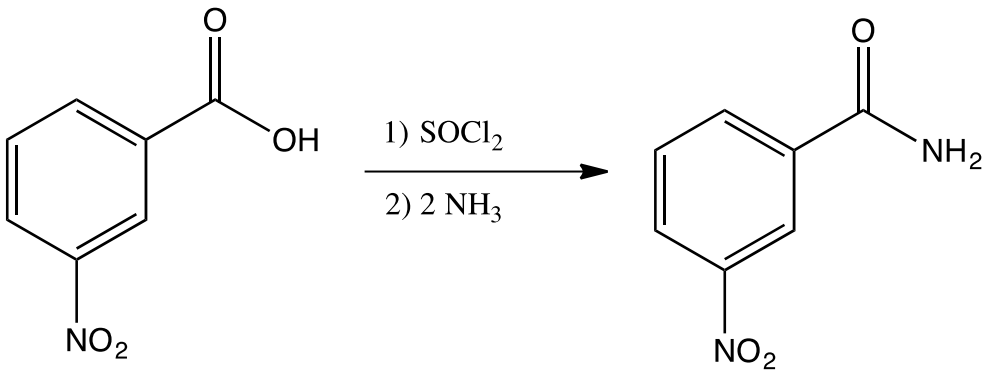
Methyl 3-nitrobenzoate

3-Nitrobenzoic acid

Reducing the Purchase of Chemicals For Experiments

Week 10

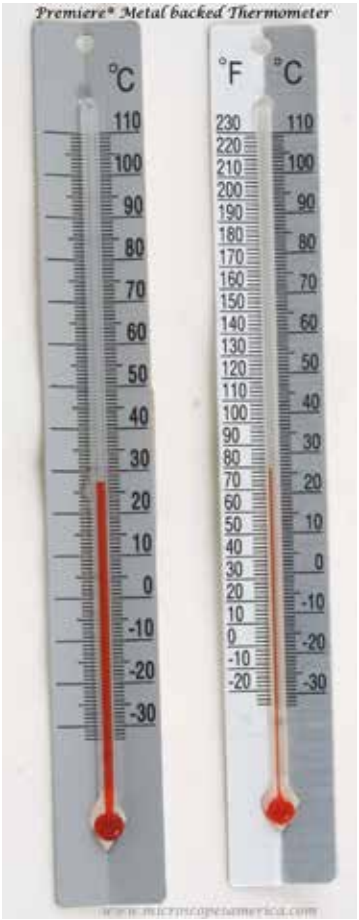
Coversion of 3-Nitrobenzoic acid to the Amide



3-Nitrobenzoic acid

3-Nitrobenzamide

Mercury Thermometers



Sharing Chemicals

Free Shelf

Chemical Inventory