10th Annual GC3 Innovators Roundtable
Session Summaries

Thursday, April 30th

Session VI

Rethinking Reuse: Green Chemistry Transforms Waste to Goods

Molly Morse, Mango Materials
Scott D. Allen, Novomer
Ramaswamy Nagarajan, University of Massachusetts Lowell
David Constable, ACS Green Chemistry Institute *(moderator)*

The transformation of waste into goods is under development in many sectors and industries. Ramaswamy Nagarajan is a professor at UMass Lowell who focuses on transforming pre-consumer waste into usable chemicals. One technology converts citrus peels and other food waste into pectin-based polymer surfactants to replace nonylphenyl ethoxylates (NPEs or Triton-X). These macromolecules work in a fundamentally different way than traditional surfactants, making them equally effective, but far less toxic. Another project involves bio-based flame retardants synthesized from the cardanol in cashew nut shell liquid—a very cheap waste feedstock from the cashew industry. The resulting oligomer is as effective as some halogenated flame retardants, but far safer. These technologies show great potential for future use in industry, but are still under development.

Mango Materials is a startup company incorporated in 2010. They are using microbes to transform waste methane into polymers (PHA) that can biodegrade in a natural environment. This can be used to replace many existing plastics—for example, aquatically biodegradable PHA could be a safe alternative to microbeads. With waste methane feedstocks around the country, e.g., from landfill gas, and relatively simple production facilities, Mango Materials could easily decentralize production. This technology could contribute to a closed-loop plastics economy, in which plastics return to the landfill and degrade into methane, which is then collected to make more plastics. Mango is currently looking for PHA buyers as well as methane-producing partners.

Novomer was founded in 2004 on two core technologies: conversion of CO_2 to polymers and CO to fine chemicals. The Novomer catalytic technology was spun out of an academic lab at Cornell, and funded initially by an SBIR/STTR. After overcoming start-up problems such as manufacturing issues, shipping, and EH&S, Novomer has

achieved commercial scale production of their primary CONVERGE® polyol products—4 basic polyols and 4 formulated products (adhesives and flexible foams). Novomer's flexible foam products are stronger and more load-bearing than conventional foams, while also having lower calorific value and thus requiring less flame retardant—a great demonstration of the "it's greener, AND…" principle.

Opportunities for Safer Chemicals and Products

- waste streams comprised of high-value chemicals
- many chemistries currently in research labs that could solve industrial problems

Key Drivers for Green Chemistry

- cheap, sustainable feedstocks
- side benefits (e.g., performance) from bio-based/green technologies
- researchers who are passionate about their green technology

Challenges for Implementation

- scaling new technologies can be very challenging
- scientists are not educated as entrepreneurs
- new technologies are often more expensive than traditional
- life cycle must be considered—could have regrettable trade-offs

Helpful Actions

- nurture and accelerate new technologies to scale
- incorporate business education into science curricula
- increase funding for tech transfer/small businesses

Role for the GC3

- advocate for entrepreneurial education in schools
- make connections between start-ups and large industrial partners, funders
- publicize funding sources for green technologies