Making more functional biopolymers

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Whether its contents are heavy-duty deli takeout for dinner or your child's new favorite toy, plastic packaging often withstands a good deal of abuse before it reaches the landfill.

Although properties such as strength, toughness, rigidity and temperature resistance make petroleum-based plastics for packaging so desirable, as trash, they can take a long time — if ever — to degrade.

"They're formulated for durability, in a sense, but are not sustainable or environmentally friendly," says Lih-Sheng (Tom) Turng, a professor of mechanical engineering at the University of Wisconsin-Madison.

In response to increased environmental concerns and, more recently, skyrocketing oil prices, Turng's research team is working to perfect bio-based plastics that hold up well in use, yet break down quickly in a landfill.

Made from renewable resources such as corn or soybeans, these bio-based polymers for plastics are commonly used in products ranging from composting bags and mulch film to baby diapers.

"We help design the materials so that they have good performance during their service, but after the service, under the proper environment, they will decompose and produce carbon dioxide, water and other biomass," says Turng. "The carbon dioxide will be used by the growing plant, thus balancing the release of carbon dioxide, a greenhouse gas contributing to global warming."

About 30 percent of plastics manufactured are used for packaging, says Turng. "So if you can actually replace those plastics with bio-based polymers, it would be a big relief for the environment," he says.

However, current bio-based polymers offer only biodegradability and not functions such as strength and heat resistance, which limit their widespread use in packaging, says Turng. "For example, if you ship a material in a container in the Arizona desert, the temperature can exceed 70 degrees Celsius inside the truck," he says. "If the product is made of or packaged with bio-based plastics, the material may deform simply due to the heat."

Collaborating with UW-Milwaukee Assistant Professor of Mechanical Engineering Sarah Gong and UW-Madison graduate students Adam Kramschuster and Alex Chandra, Turng is hoping to enhance the material properties of bio-based plastics.

The group is incorporating additives such as nano clay, carbon nanotubes and natural fibers into bio-based polymers to improve key properties such as strength and heat resistance. In addition, the researchers are studying ways that they can exploit processes like extrusion and injection molding to influence bio-based polymer properties and their microstructure. Already, they are working with manufacturers to incorporate their findings, primarily into polymers for plastic packaging.

The group also is studying ways to use bio-based polymer technology for medical applications. For example, says Turng, if you fracture a bone, a biodegradable material could stabilize the bone or provide a scaffold on which new tissue could grow. The researchers are perfecting techniques through which they can make polymers with a microcellular structure that mimics bone. "We can make this kind of plastic with the proper microstructure," he says.

Source: University of Wisconsin-Madison, by Renee Meiller