Researchers use plant oils for novel bio-based plastics

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Michael Kessler, left, a professor in the Washington State University School of Mechanical and Materials Engineering, has developed polyurethane based on plant oils. He is seen here with Tom Garrison, a WSU clinical assistant professor. Credit: Washington State University

Washington State University researchers have developed a new way to

use plant oils like olive and linseed oil to create polyurethane, a plastic material used in everything from foam insulation panels to tires, hoses and sealants.

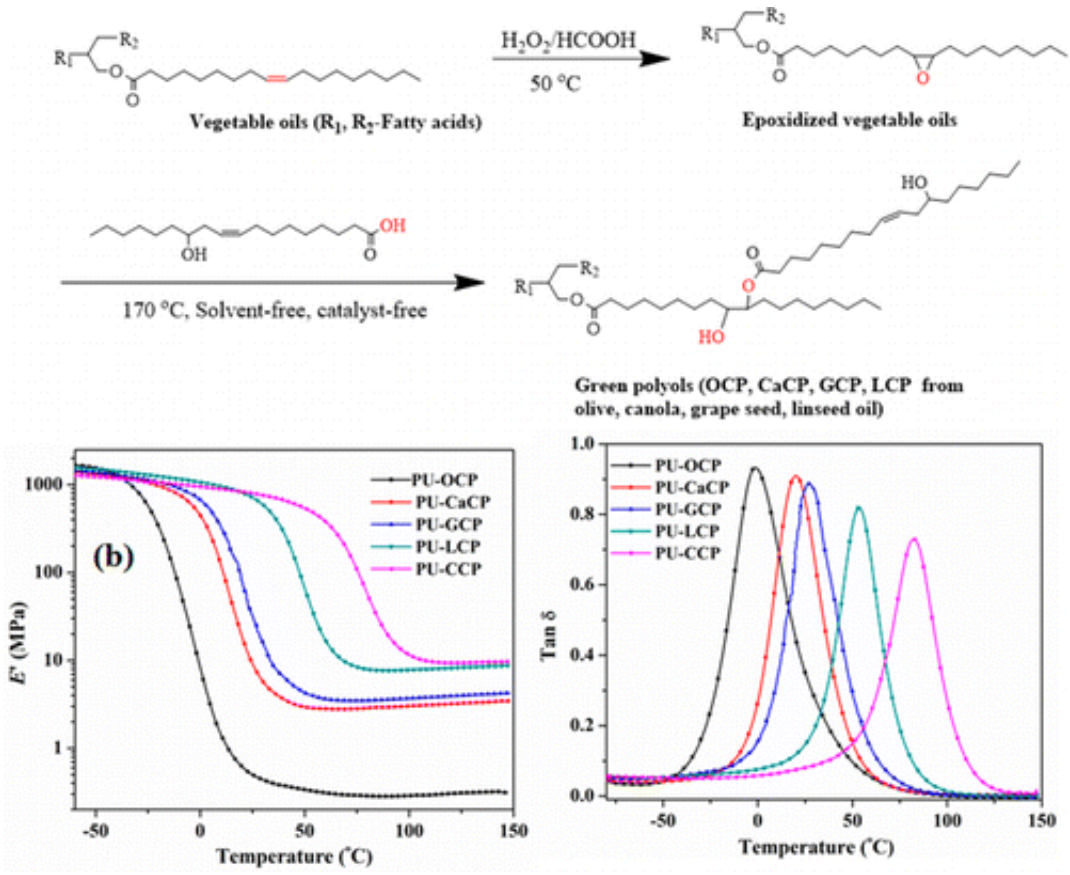
The researchers, led by Michael Kessler, Berry Family director and professor in WSU's School of Mechanical and Materials Engineering, have published a paper on the work in the journal *ACS Applied Materials & Interfaces*.

Polyurethane is extremely tough and corrosion- and wear-resistant, but researchers would like a more environmentally friendly alternative to the petroleum-based product. About 14 million tons of polyurethane was produced in 2010, and production is expected to increase by almost 30 percent by 2016.

While there are already some polyurethanes made from plant materials, Kessler's research group developed a new method that uses vegetable oils to create materials with a wide variety of flexibility, stiffness and shapes. Plant oils are inexpensive, readily available, renewable and can be genetically engineered.

In the study, the researchers made polyurethane using olive, canola, grape seed, linseed and castor oils. While other researchers have struggled with using petroleum-based solvents, the WSU researchers, working with colleagues from Iowa State and from Cairo universities, didn't use solvents or a catalyst in their production.

To make polyurethane, manufacturers combine two types of chemical compounds in a reaction. One of the chemicals is a polyol, which is a compound with multiple hydroxyl functional groups that are available for reaction.



Some oils, like linseed oil, have five or six reactive sites, making the material stiffer. Others, such as olive oil, have fewer reactive sites, making the material more flexible.

"What's new about this is specifically the way we make the polyols," said Kessler, who compared the process to building with Legos. "It is the same concept with these chemical groups. They click together and form a chemical bond.

"The novelty of this particular work is that these polyurethanes are using a new chemistry made by a combination of castor oil fatty acid and

modified vegetable oils," he said.

Kessler, who is director of the Center for Bioplastics and Biocomposites, hopes that the method is appealing to the plastics industry. The center, a collaboration between WSU and Iowa State University, is the first industry and university cooperative research center devoted to the development of biologically based plastics.

It got underway earlier this year with a grant from the National Science Foundation and brings together partners to conduct research that is particularly relevant for industry with a high potential for commercialization. A total of 24 companies are members of the center.

More information: Biobased Polyurethanes Prepared from Different Vegetable Oils, *ACS Appl. Mater. Interfaces*, 2015, 7 (2), pp 1226–1233. DOI: 10.1021/am5071333

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