Turning pine sap into 'ever-green' plastics

February 21 2013, by Steven Powell

You might be able to avoid the recycle bin with “ever-green” plastics being developed in Chuanbing Tang’s laboratory.

Plastic bags are a bane of nature. And not just bags – just about all plastics, really. Most are made out of petroleum, and a piece of plastic, if it misses the recycling bin and ends up in a landfill, will probably outlast human civilization.

But Chuanbing Tang at the University of South Carolina is developing new plastics that are "green" from the cradle to the grave. Given that the new polymers he's working on often come from pine trees, firs and other conifers, he's giving the word "evergreen" added resonance.

Rather than tapping a barrel of oil to obtain starting materials, Tang's research group instead begins with the natural resins found in trees, especially evergreens. The rosin and turpentine derived from their wood is rich in hydrocarbons, similar but not identical to some components of petroleum.

Hydrocarbon-rich starting materials, whether from petroleum or tree resin, can be converted into various forms of what are commonly termed "plastics" through polymerization. With petroleum derivatives, scientists have invested more than a hundred years of research into refining the polymer chemistry involved, and their success in that endeavor is evident in the range of plastics now part of common parlance, such as Plexiglas, polycarbonate and PVC.

But processes for developing plastics from renewable sources, such as rosin and turpentine, are not nearly as developed. "Renewable polymers currently suffer from inferior performance in comparison to those derived from petroleum," Tang said.

His laboratory is a national leader in helping change that situation. Tang just received a National Science Foundation CAREER award to further develop the polymer chemistry he has been refining since he arrived as a chemistry professor in USC's College of Arts and Sciences in 2009. The award from NSF's Division of Materials Research will support Tang's laboratory through 2018.

"The aim is to understand how the macromolecular compositions and architectures dictate the properties of the materials we make," Tang said. "If we can establish clear structure-property relationships, we will be able to achieve the kinds of results we now get from polymers made from petroleum."

According to Tang, molecules derived from wood products are particularly worthwhile targets. "They're a rich source of the cycloaliphatic and aromatic structures that make good materials after polymerization," he said. "They have the rigid molecular structures and hydrophobicity that materials scientists know work well."

They also have an advantage at the end of their life cycle. By virtue of being a direct product of biology, the renewable starting materials are a familiar sight for the microbes responsible for biodegradation. "Most plastics from non-renewable resources are generally not biodegradable," Tang said. "With a polymer framework derived from renewable sources, we're able to make materials that should break down more readily in the environment."

Together with graduate student Perry Wilbon, Tang worked with Fuxiang Chu of the Chinese Academy of Forestry to prepare the first comprehensive review of terpenes, terpenoids, and rosin, three components of tree resin (and other natural products as well) that are plentiful sources of cycloaliphatic and aromatic structures. Published as the cover article in Wiley's Macromolecular Rapid Communications in January 2013, the review is a blueprint for just one approach that Tang is taking to develop sustainable polymers from the greenest of sources.

Provided by University of South Carolina

Citation: Turning pine sap into 'ever-green' plastics (2013, February 21) retrieved 11 July 2024 from https://phys.org/news/2013-02-sap-ever-green-plastics.html