Center for Tire Research (CenTiRe)

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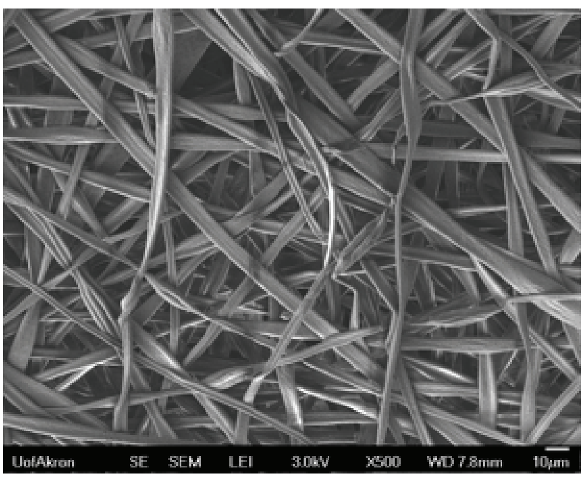
Recyclable Thermoplastic Rubber: A Boon for Tires and Healthcare

This project addresses important technology gap(s) as it translates from research discovery toward commercial application. It enables production of halogen-free rubber on a commercial scale. The breakthrough product will compete with current halobutyl rubber (current global production is ~1 million tons per year) by producing thermoplastic biocompatible rubber that requires fewer resources to produce and a simplified production process. This breakthrough material is much easier and cheaper to make than earlier versions of polyisobutylene-based thermoplastic rubbers. As a result, that scale-up is faster; the reactions are usually complete in less than 10 minutes.

In radial car tires there is a thin layer of halogenated butyl rubber to keep the tire inflated -- without that drivers would have to pump up their tires almost daily. The original aim of this research was to produce butyl-type polymers by copolymerizing isobutylene with alloocimene, a terpene from natural resources, using the commercial butyl rubber process.



Scanning Electron Microscopic image of the drug eluting fibers

Alloocimene is a renewable monomer. Allomatrix can also be crosslinked if necessary. Initial tests indicate that it is quite biodegradable under specific conditions. This is the first material that could be a potential replacement of halobutyl rubber without halogen content. It can be electrospun into a drug eluting fiber mat to be used on medical implants.

With additional support from the Rubber Division of the American Chemical Society, Wyatt Technology and the Breast Cancer Innovation Foundation of Akron, supporting the research of integrating breast reconstruction with cancer diagnosis and treatment using electrospun Allomatrix fiber mats. Puskas received a PFI:AIR Research Alliance Grant from NSF, with maximum matching ($800,000 from NSF matching > $800,000 cash from industry and investors). The PFI:AIR project focuses on the translation and transfer of the Allomatrix technology and the development of an academic-based innovation ecosystem.

The new breakthrough copolymers (referred to as "Allomatrix") are thermoplastic rubbers that can be more easily melted and recycled. They have a high potential for replacing halobutyl rubber in car tires and for health care applications such as pharmaceutical stoppers and implant coatings. An earlier thermoplastic rubber that contains isobutylene and styrene, co-invented by a University of Akron researcher, is used as a drug eluting coating on Taxus coronary stents. Such stents have been implanted into more than 6 million patients since its FDA approval in 2004, saving countless lives. Based on the development of the stent coating rubber and Allomatrix, the "Rubber World" journal listed Puskas among the 125 inventors who had major impact on the rubber industry during the past 125 years.

Car tires could be made from a more biocompatible rubber that requires fewer resources to produce and a simplified production process. Image courtesy of Goodyear.

The Allomatrix family of polymers uses raw materials from renewable resources, and is a potential replacement of halobutyl rubber, which is used to make the gas-barrier inner liner of car tires and pharmaceutical stoppers. It also has the potential to be used as a rubbery biomaterial that can be processed as plastic and can be recycled, with better combination of properties than silicone rubber. These features provide the performance of commercial halobutyl rubber without the presence of harmful halogens. With further development, this project has the potential to bring back high value-added manufacturing to the USA, especially for biomedical applications, creating jobs in the STEM disciplines.

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