Sustainable chemistry based on wood

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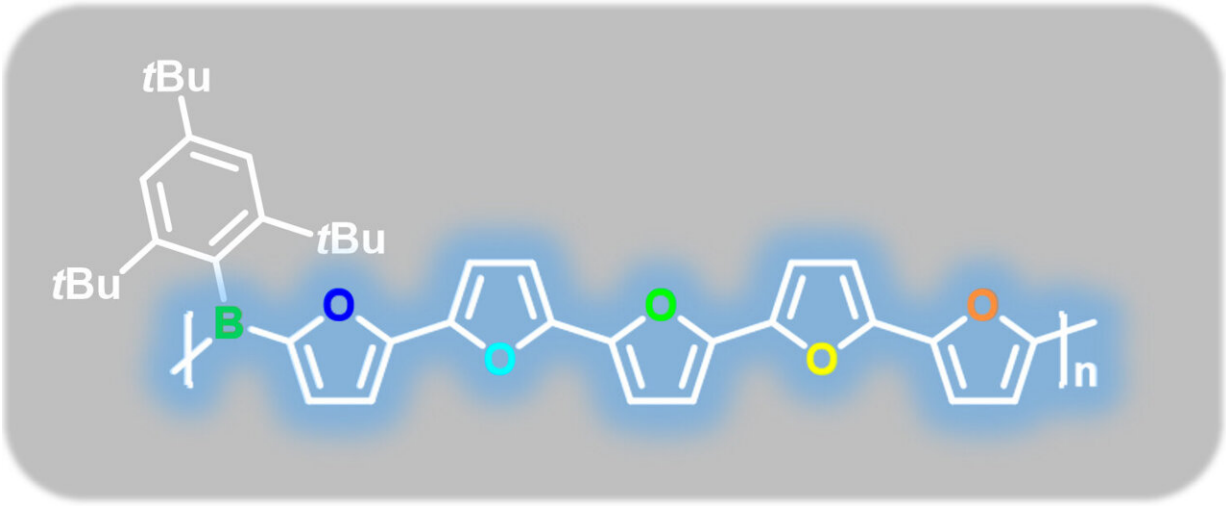

Example of a boron-containing polymer based on furan. Credit: Maximilian Fest / University of Würzburg

Some hikers carry a small solar power generator with them, a foil attached to their backpack that converts sunlight into electricity. This allows them to charge their devices while on the move. Flexible, thin and lightweight solar panels can also be attached to outdoor clothing or glued to curved surfaces such as the roofs of mobile homes.

Such solar cells capture the sun's energy not with crystalline silicon, but with special organic materials. Unfortunately, these materials have so far been made from non-sustainable crude oil or natural gas.

So scientists are looking for alternatives. The team led by chemistry professor Holger Helten from the Julius-Maximilians-Universität (JMU) Würzburg in Bavaria, Germany, has a focus on the renewable raw material wood. Furans can be derived from wood, and these ring-shaped molecules are suitable for organic electronics such as solar cells, light-emitting diodes, displays or electronic circuits.

Boron stabilizes furan-based polymers

Crucially, furan-based materials have much better properties for many applications than most materials used in organic electronics to date. Compared to standard thiophene-based materials, they have, among other things, a stronger luminosity and are more soluble—this simplifies their processing and saves solvents. Furans are also biodegradable, which is why such materials can probably be recycled.

Unfortunately, most furan-based materials are very unstable under ambient conditions; they decompose quickly in the presence of oxygen and light. But they can be stabilized by linking them with the element boron. "This produces compounds that can withstand temperatures of up to 300 degrees Celsius and remain unharmed by light for months," says JMU chemist Maximilian Fest, who is doing his doctoral thesis under Professor Helten.

Environmentally friendly synthesis methods in use

Research into boron-containing polymers is still in its infancy. The Würzburg doctoral student is synthesizing new variants from boron and furans and characterizing their properties. In doing so, he relies on environmentally friendly synthesis methods that are being developed in his professor's working group.

Holger Helten explains why these methods are environmentally friendly: "The polymerisation of boron and furans, but also the synthesis of purely organic polymers, usually produces very questionable waste products. Often, these are organic tin compounds that are highly toxic to humans and the environment. With our approach, no metals are needed and no toxic waste is produced."

His team wants to further improve these synthesis processes, to make them even more sustainable. One goal is to reduce the number of reaction steps—which saves energy and reagents.

The incorporation of boron into furan-based polymers opens up many other possibilities beyond organic electronics. "We can use it, for example, to build sensors that detect toxic amines and other substances," says Professor Helten. Such polymers can also be used as catalysts for chemical reactions or as electrode materials for lithium-ion batteries.

Provided by Julius-Maximilians-Universität Würzburg

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