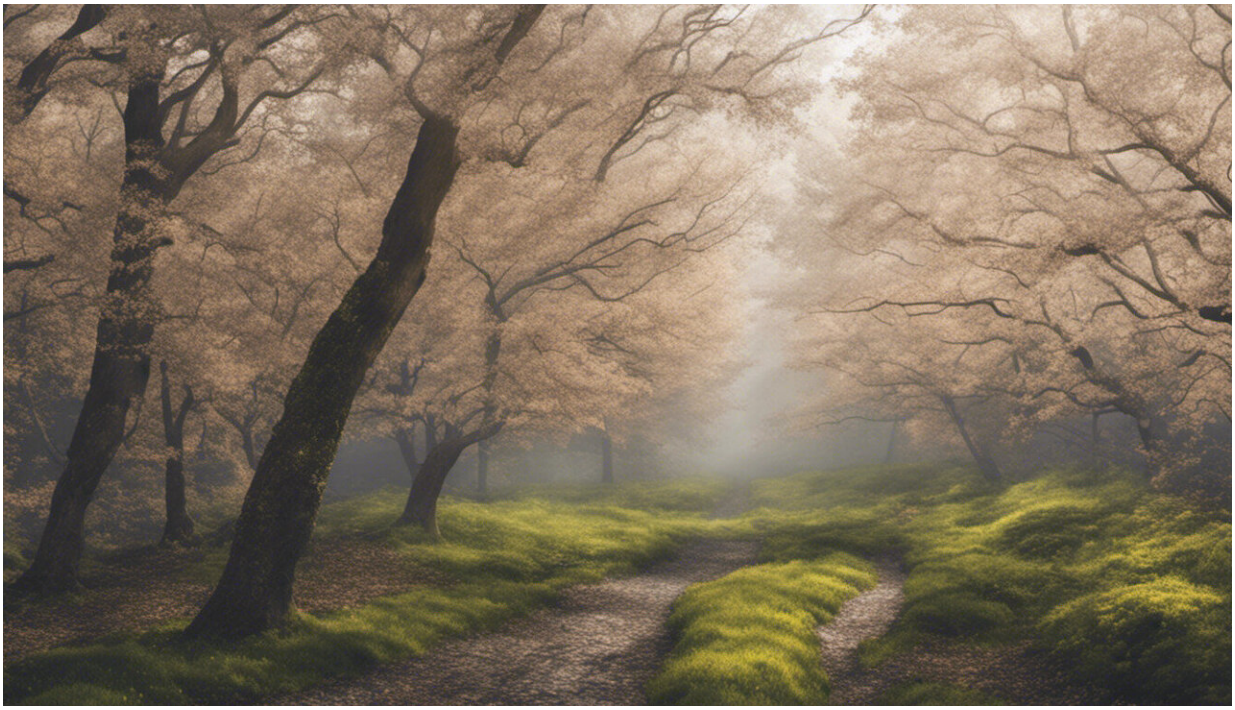
A simpler path to a catalyst

November 6 2012, by Fabio Bergamin



Credit: AI-generated image (disclaimer)

Researchers at ETH Zurich developed a new synthesis procedure for a catalyst. This procedure may be used for the large-scale production of, for instance, plastics from renewable resources in an environmentally friendly and efficient manner.

It started with an idea of Ive Hermans, Assistant Professor at the Institute of Chemical and Bioengineering: The chemist and his co-

workers were looking for a new synthesis procedure for an important catalyst for the chemical industry. To date, the synthesis of the catalyst occurs in a very complex and error-prone procedure. The ETH researchers discovered a far more convenient two-step procedure, which is more suitable for large-scale production.

The catalyst in question is a zeolite, a powdery, porous, particulate material. Like all catalysts also this substance can accelerate a certain reaction and/or steer it towards a desired product. Hermans and his co-workers wanted to develop a catalyst that facilitates oxidation reactions and can thus be used for the preparation of so-called lactones from ketones.

"The new method is surprisingly easy"

The use of a catalyst for such reactions has many advantages. "The preparation of lactones, for instance, is time-intensive and expensive, as acids are formed as side-products", says Hermans. By using a tin containing zeolite as a catalyst instead, it becomes possible to use hydrogen peroxide as an oxidation reagent so that water is the only side-product. This method has not been implemented industrially so far, due to the time-consuming synthesis procedure of the special zeolites: the process requires 40 days. In addition, the procedure is difficult to control and can easily fail.

The idea of the ETH researchers: Instead of synthesizing the zeolite in a procedure which takes a great deal of time, out of silicon, aluminum and tin, they used a commercially available zeolite made of silicon and aluminum. Within two steps this material was modified to the desired catalyst. "At first, we removed the aluminum atoms from the raw material in a known procedure without changing the crystalline structure of the zeolite", says PhD student Sabrina Conrad. "Then we replaced the vacant sites inside the zeolite framework with tin atoms by mixing the

pretreated zeolite with a tin compound for 15 minutes." Experiments have shown that the newly prepared zeolite contains more tin than conventionally prepared catalysts. Due to that, the catalyst is significantly more efficient.

Environmentally friendly preparation procedure

In cooperation with an industrial partner, the ETH researchers want to optimize the preparation procedure for large-scale applications. In the future, the catalyst could be used for the industrial synthesis of starting materials required for important plastics. One example would be the preparation of polylactic acid from renewable resources. Polylactic acid is being used in plastic packing materials or foil. "The demand for plastics made from renewable resources will strongly increase as soon as crude oil – the basis of many plastics – will become more rare and expensive", explains Hermans. "With our catalyst, it is possible to produce such products on a large scale in a much more environmentally friendly way. "

More information: Hammond C, Conrad S, Hermans I: Simple and Scalable Preparation of Highly Active Lewis Acidic Sn-beta. *Angewandte Chemie International Edition*, 2012, 51: 1-5. DOI: 10.1002/anie.201206193

Provided by ETH Zurich