Biomass as a source of raw materials

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For the protection of the environment, and because of the limited amount of fossil fuels available, renewable resources, such as specially cultivated plants, wood scraps, and other plant waste, are becoming the focus of considerable attention. Processes such as pyrolysis or liquefaction allow the conversion of biomass into bio-oil, a highly promising renewable source of energy.

A team of German and Chinese scientists led by Johannes A. Lercher at the Technical University of Munich has now developed a new catalytic process to convert components of bio-oil directly into alkanes and methanol. As reported in the journal *Angewandte Chemie*, the process is based on a "one-pot" reaction catalyzed by a precious metal on a carbon support combined with an inorganic acid.

Bio-oil is an aqueous, acidic, highly oxidized mixture. However, its high oxygen content and instability turn out to have a negative impact: bio-oil cannot be used directly as a liquid fuel. It would, however, be highly interesting as a source of basic raw materials if it were possible to convert it to alkanes. Alkanes, which are also commonly called paraffins, are saturated hydrocarbons; they are among the most important raw materials for chemical industry, and in particular as starting materials for the production of plastics. Furthermore, they are among the primary fuels in the world's economy.

Bio-oil contains a phenolic fraction consisting of compounds with the main framework being an aromatic ring made of six carbon atoms with some hydroxy (-OH) groups attached. With the new process, the

phenolic components of bio-oil can be converted with high selectivity to cycloalkanes (ring-shaped alkanes) and methanol. The researchers were able to demonstrate this with various model substances. As catalyst, they used palladium metal on a carbon support, with phosphoric acid as the proton source for the reaction.

The reaction is a "one-pot" reaction, meaning a one-step reaction whose partial reactions (hydrogenation, hydrolysis, and dehydration) occur in the same reactor, with no intermediate work-up. The secret is in the catalyst, which works on all of these different reactions. The end result is a mixture of various alkanes that separates into a second phase, making it easy to separate from the aqueous bio-oil phase. The new process is a practical approach for the direct use of bio-oil for the production of alkanes.

More information: Johannes A. Lercher, Highly Selective Catalytic Conversion of Phenolic Bio-Oil to Alkanes, *Angewandte Chemie International Edition* 2009, 48, No. 22, 4047-4050, doi: 10.1002/anie.200900404

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