Green Indicator

With the end of 2011 and with 2012 ahead of us, with endless possibility, a new edition of the green indicator is in place. In this number we will have a look at the new concept of tandem catalysis, structured surfaces for sequential reaction, and venture a guess on where these may be used in the future. We will consider the feasibility of using tobacco as an energy crop for the biodiesel supply chain.

/ Christian Hulteberg

Unexpected help in the biodiesel supply chain

There have been a lot of discussions on the topic of oil supply to the biodiesel industry. The fuel vs. food debate has had its influence, as well as fundamental questions on total supply, and the use of non-traditional agricultural soil is to be preferred. A lot of this discussion has focused on jatropha as an alternative, high yielding crop; the crop is also poisonous. This is both an advantage and a disadvantage as it both "kills" the fuel vs. food debate and renders the resulting pressing cake unsuitable for fodder applications.

As a suggestion, researchers and agronomists are investigating tobacco as an alternative crop for oil and energy production. As jatropha, tobacco can grow on marginal soil and is therefore not competitive with traditional food crops. Its oil yield is also very high compared to other oil crops, with yield in the 2000 l/ha range compared to 1000 l/ha for rapeseed, 600 l/ha for sunflower and 400 l/ha for soybean.

The crop has several advantages compared to jatropha, used here as a means of comparison. First of all, there is already a commercial growth of tobacco in many different climate zones and soil types so this experience can be used when introducing tobacco as an energy

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Tandem Catalysts

The notion of tandem catalysts, the assembling of metal nanocubes on an oxide surface such as silica and then with an additional metal oxide nanocube assembled on top of the metal, was first introduced in Nature Chemistry last year (3 (2011) 372). By creating layers of nanocubes less than 10 nanometers thick, specifically active catalytic interfaces between metal and metal oxides are formed and since the distance between these interfaces, the catalysts created are suitable for sequential or tandem reactions.

In the paper, the first set of reactions investigated was the formation of carbon monoxide and hydrogen from methanol and the use of these products in the hydroformulation of ethylene to form propionaldehyde. The advantage of performing this reaction in the gas-phase as opposed to the liquid phase is that the use of homogeneous Rh-complexes may be avoided and that the levels of carbon monoxide and hydrogen may be kept low. What is more interesting is that the selectivity is quite high, but also that the

be used as a high protein livestock fodder. Thirdly, the crop is annual and the harvesting is therefore much easier than in the jatropha case, requiring picking of the nuts without harvesting the plant.

So what are the drawbacks then? Well, first of all the current method of planting the tobacco seeds in greenhouses for later transplantation in the field, usually by hand, need to be made more efficient and the seed need to be able to be planted directly into the soil. Secondly, producing tobacco as an energy crop will be different to growing it for human consumption and these differences will have to be understood and addressed. Thirdly, the resulting oil contain very high concentrations of linoleic acid (C18:2), as high as 75%, and the production of biodiesel from this relatively mono-fatty acid oil will have to be thoroughly understood with respect to required additives etc.

In conclusion, the current high yield of oil from tobacco and its suitability for genetic modifications, tobacco is often used as a model plant for genetic transformation, makes it a suitable energy-crop candidate for non-traditional agricultural soils. Indeed, the US DoE awarded $4.9 million to engineer tobacco for the production of vehicle fuels to Berkley in September of 2011 and much progress within this area is expected over the forthcoming years.

possibly through electric-modification effects caused by the ceria present. All of these experiments were run in a closed circulation set-up and now the next challenge will be to scale up the designed catalyst and make it into a commercially viable process.

Even though this first chosen reaction is of interest, there are other challenges in which this type of catalytic materials may be a success factor. These include artificial photosynthesis, where water is both oxidized and reduced and carbon dioxide is reduced. And if this is successful, why not take a step into the electrofuel direction (fuel synthesis where solar derived electricity, hydrogen or metal ions are used to convers carbon dioxide to fuels) and thus take up the challenge alongside the microorganisms usually considered.

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