Research team develops better iron catalyst to help turn plant material into plastic

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(PhysOrg.com) -- As most people know, modern plastics are made from crude oil derivatives, making them vulnerable to price and supply fluctuations, which in the end means an alternative must be found in order for the plastics industry to remain viable. One alternative is to use plant material, or biomass instead. Unfortunately, at least till now, the lack of a good catalyst has made the process both expensive and messy, at least for those that create plastics that are virtually identical to the ones based on petroleum. Now, researchers in The Netherlands have found an iron catalyst that appears to be both effective and doesn't produce a messy byproduct. They describe their work in the journal *Science*.

Biomass can be used to make plastics by burning it which produces a mix of carbon monoxide and hydrogen. When a catalyst is added to the mix, (most of which are generally based on iron) syngas is produced with olefins in it. The olefins are the components in syngas that form into plastic when they are chemically connected together. The problem up till now has been that the catalysts used thus far haven't been very efficient (the proportion of olefins in the syngas were very small) and tended to produce carbon dust and methane.

In this new research, the team studied many different iron based materials hoping to find one that would work better. After an exhaustive search they discovered that by changing the grain size of one such catalyst material from an average of 500 nanometers to just 20, and then forcing the grains to be evenly spaced apart to prevent clustering, improved efficiency dramatically. Then, by accident (one of their chemicals had been accidently tainted) they found that adding a tiny bit of sulfur and sodium to the mix improved the efficiency even more. The end result is a process so efficient that no carbon dust or methane is produced.

The researchers acknowledge that the process still isn't efficient enough to compete with those based on petroleum products, despite the fact that it produced roughly fifty percent more lower olefins than previous methods. At just 60% efficiency, that still leaves 40% waste, too much for it to be considered a viable replacement, at least at current oil prices and availability. More optimistically, the fact that the team was able to double the efficiency of current methods suggests that even better efficiencies in the future might be found.

More information: Supported Iron Nanoparticles as Catalysts for Sustainable Production of Lower Olefins, *Science*, 17 February 2012: Vol. 335 no. 6070 pp. 835-838. DOI: 10.1126/science.1215614

ABSTRACT
Lower olefins are key building blocks for the manufacture of plastics, cosmetics, and drugs. Traditionally, olefins with two to four carbons are produced by steam cracking of crude oil–derived naphtha, but there is a pressing need for alternative feedstocks and processes in view of supply limitations and of environmental issues. Although the Fischer-Tropsch synthesis has long offered a means to convert coal, biomass, and natural gas into hydrocarbon derivatives through the intermediacy of synthesis gas (a mixture of molecular hydrogen and carbon monoxide), selectivity toward lower olefins tends to be low. We report on the conversion of synthesis gas to C2 through C4 olefins with selectivity up to 60 weight percent, using catalysts that constitute iron nanoparticles (promoted by sulfur plus sodium) homogeneously dispersed on weakly interactive α-alumina or carbon nanofiber supports.