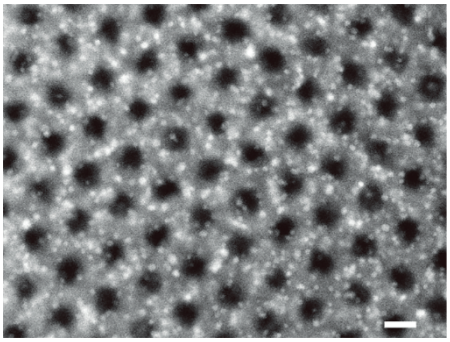
research highlights

CATALYSIS

Bimetallics for biofuels

Angew. Chem. Int. Ed. **55,** 8850–8855 (2016)



WILEY

Reducing the oxygen content of biomass-derived feedstocks is key to producing quality liquid biofuels with high energy density and stability. However, harsh conditions are often required to perform the catalytic hydrodeoxygenation (HDO) process and more effective catalysts are sought that can operate in milder conditions. Now, Ferdi Schüth and colleagues in Germany and the UK demonstrate how small, bimetallic PtCo nanoparticles supported on nitrogen-doped mesoporous carbon are highly active and selective catalysts for the HDO of compounds derived from biomass, generating product streams suitable for use as drop-in fuels.

To prepare the catalysts, the researchers used a soft-templating method to yield nitrogen-doped carbon with well-defined pores in either a cubic or hexagonal arrangement, depending on the polymerization temperature. They then introduced uniformly dispersed 1.5 nm PtCo nanoparticles by ion-exchanging appropriate metal salts into the polymerized precursor before pyrolysis in a stream of dilute hydrogen at 500 °C. The resulting catalysts produce alkanes from phenolic compounds with high selectivity (>99%) at high conversion, while, by comparison, monometallic catalysts based on Co or Pt are less active and selective. The catalysts also perform well in the conversion of bio-oil — a complex mixture of phenols derived from lignin — producing a product stream composed of 99% carbon and hydrogen, mainly in the form of cycloalkanes. *JG*

ORGANIC SOLAR CELLS

A new partner for P3HT

Nature Commun. **7,** 11585 (2016)

Organic solar cells (OSCs) can be solution-processed and are thus a potentially low-cost alternative to silicon-based photovoltaic devices. However, the highest-performing OSCs use materials, such as fullerene acceptors, that are costly, difficult to produce on an industrial scale and that have limited stability. Poly(3-hexylthiophene) (P3HT) is a relatively stable donor polymer that can be synthesized in large quantities at low cost. Sarah Holliday, Iain McCulloch and colleagues at Imperial College London and elsewhere have now designed a non-fullerene small molecule acceptor called IDTBR that, when partnered with P3HT in a bulk heterojunction solar cell, achieves a power conversion efficiency (PCE) of 6.4% — a record value for fullerene-free solar cells with a P3HT donor.

The IDTBR acceptor has an indacenodithiophene unit at its core, and benzothiadiazole and rhodanine flanking groups. Its planar structure improves crystallization and morphological properties and red-shifts the optical absorption to make it complementary to that of P3HT. Its properties can be further tuned by side-chain engineering with either *n*-octyl or 2-ethylhexyl chains. The solar cells have an inverted architecture of glass/ITO/ZnO/P3HT:IDTBR/MoO_3/Ag and their PCE is much higher than that of fullerene-based control samples (reaching only 3.7%). Moreover, the IDTBR-based devices retain 73% of the original PCE after 1,200 hours in air, which is significantly higher than in control samples. *ED*

CARBON DIOXIDE REDUCTION

Copper plus

Nature Commun. **7,** 12123 (2016)

Electrochemical reduction of CO_2 not only reduces its emission into the atmosphere but also generates useful fuels such as methane, ethylene and other compounds. Cu-based catalysts have been shown to be active for the reaction but applications have been plagued by the relatively high voltages that are required during operation. Furthermore, fundamental understanding of the Cu redox chemistry that governs the conversion of CO_2 is elusive, as most studies are based on *ex situ* techniques. Beatriz Roldan Cuenya and colleagues in Germany and USA have now reported plasma-activated Cu catalysts with high selectivity (60%) towards ethylene formation and employed *in operando* techniques to analyse the activity and selectivity of the catalysts in their working state.

The researchers used a plasma activation method to synthesize oxidized Cu catalysts, which exhibit roughened nanostructured surface layers with CuO at the top and Cu_2O in the interlayer above the crystalline Cu. During the early period of the CO_2 reduction reaction, the surface layers reconstruct, becoming somewhat depleted in oxygen and rich in Cu^+. Importantly, following these initial changes, the Cu_2O species were found to be relatively stable in the surface layer while the activity and selectivity remained almost unchanged, suggesting the significant role of Cu^+ in the reaction. This result challenges the conventional view that metallic Cu is the only active species. *CZ*

SMART METERS

Unintended consequences

Energy Effic. http://doi.org/bmtr (2016)

It is usually assumed that policy aimed at encouraging pro-environmental behaviours normally has positive spillover into other domains. However, this is not always true and negative spillover effects can also arise. Daire McCoy and Sean Lyons from Trinity College Dublin analysed data from 2,456 households in Ireland in a randomized-controlled electricity smart-metering trial and found empirical evidence that an intervention targeted to reduce energy consumption actually reduced overall engagement in energy efficiency investments.

Using data from the Irish Commission for Energy Regulation Smart Metering Customer Behavioural Trial, the authors observe that households randomly assigned to one of the three possible groups that received augmented information on their energy consumption (treatment groups) are 23–28% less likely to adopt any energy saving measure over the 12-month trial period compared with those in the control group. This behaviour can have different root causes, but in particular it can be associated with a moral licensing effect: individuals who are secure in the knowledge of their past good behaviour can feel justified in doing 'something bad', freed from the anxiety that might otherwise impact their decisions. This reminds us that policy targeting one type of intervention might have unintended consequences on other behaviours. *AR*

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