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**Guest Editorial**

# A Greener Future?

How good are we at predicting the future impact of science and technology? In her book "Science and the City: The Mechanics Behind the Metropolis" (1), Laurie Winkless anticipates a modern city based on a circular economy, in which numerous technologies are used to eke out the highest efficiency from both renewable and non-renewable resources, while carbon and water are kept in play through multiple recycling. Surprisingly few of these technologies are radically new. Many have been around for decades, if not centuries, and often they have been inspired by nature.

In this special issue of *Johnson Matthey Technology Review*, several emergent technologies are considered, which address two of the most persistent environmental problems facing modern society: the discharge of contaminated water and the large-scale release of carbon dioxide. As we see, the underlying concepts are well established, but the specific applications are novel.

## Catalysis for Clean Water and Clean Air

There are two articles on water purification, each using a different catalytic strategy to target the removal of organic contaminants from industrial wastewater. Saunders *et al*. (2) describe the use of catalytic wet air oxidation, in which the challenge is to develop catalysts that will operate at temperatures below 100ºC, avoiding the need for elevated pressures to keep the water in the liquid phase. Perhaps surprisingly, some of the best new catalysts appear to repel water, but it is their relative wettability on the microscopic scale that is critical, helping direct the oxygen (from the air feed) and the organic molecules (in the contaminated water) to the catalytically active sites. This is all a bit like the hydrophilic and hydrophobic patterning on the wings of a Namib beetle (1), which enables moisture from the air to be directed to the mouth of the insect!

Underhill *et al*. (3) take a different approach to the decontamination of wastewater, though their aim is still to achieve full oxidation of dissolved organic molecules. In their approach, they use catalysis to generate peroxide species as the oxidising agent at the point of use. Significantly, they show that when the peroxide species are formed *in situ*, they are more effective than when added as hydrogen peroxide solution. As Winkless has pointed out (1), this approach could be adapted for the treatment of household greywater, which is the lightly contaminated wastewater from washing and bathing. The water could be re-used following treatment in a domestic appliance that combines filtration with catalytic disinfection based on the type of catalysis described by Underhill *et al*.

The catalytic theme persists throughout this issue. Whereas Winkless has suggested that "catalytic converters are due a reboot" (1), Leung *et al*. (4) describe here how a catalytic reformer – similar in composition and design to that of a three-way catalytic converter – can be used to recover waste heat from vehicle exhaust. This type of catalytic heat recovery could allow gasoline fuelled vehicles to match the low fuel consumption and $CO_2$ emissions of diesel vehicles, without needing to 'reboot' the three-way catalytic converter that does so well in controlling the release of NOx, CO and hydrocarbons. The technology could prove vital in stabilising urban air quality over the next two decades, while road transport transitions from the internal combustion engine to the electric powertrain.

## Lowering Carbon Dioxide Emissions

On a different scale of application, but with the same aims of reducing $CO_2$ emissions and increasing energy efficiency, van Dijk *et al*. (5) provide an overview of the multi-partner STEPWISE project. The technology, which is custom designed for the iron and steel manufacturing industries, is at a much more advanced stage of development than any of the others described in this issue. During the lifetime of the project, pilot plant testing will be carried out on a carbon-storage system for processing up to 14 tonnes of $CO_2$ per day. As van Dijk *et al*. state in their article: "To put that in context, on average a car emits 4.75 tonnes in a year", and yet the pilot plant will be processing only 1% of the $CO_2$ released by the blast furnace of a typical steel manufacturing plant.

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