From pollutant to profit -- nanoscience turns carbon on its head

March 23 2010

Three new complementary research projects will turn carbon from a pollutant into useful products that could help both industry and the environment.

Nanotechnology solutions will be used to:

- convert carbon dioxide (CO_2) into chemicals that could be used in fuel cells for laptops and mobile phones at University College London
- produce vehicle fuels from CO_2 using an 'artificial leaf' concept at Imperial College London
- remove CO_2 from the atmosphere and lock it into useful products such as polymers, carbohydrates or fuels at the Universities of Bath, Bristol and West of England.

The research is part of the Engineering and Physical Sciences Research Council (EPSRC) 'Nanotechnology Grand Challenge' programme and will receive a total investment of £4m.

Catalytic reactor

University College London scientists led by Professor Nora De Leeuw will work with Johnson Matthey to mimic biological systems and

produce a catalytic reactor that can convert CO_2 into useful chemicals for applications such as fuel cells in laptops and mobile phones.

The reactor will use novel nano-catalysts based on compounds formed in warm springs on the ocean floor that are considered to have triggered the emergence of life. The team's design will take inspiration from biological systems that can carry out complex processes to convert CO_2 into biological material, and exploit a wide range of computational and experimental chemistry techniques.

Professor De Leeuw says: "If we were able to emulate nature and convert CO_2 into useful products without having to use large amounts of energy, the benefits would be enormous. One of the major gases responsible for climate change would become an important raw material for the chemical and pharmaceutical industries."

Artificial leaf

At Imperial College London and University College London a research team led by Dr Charlotte Williams will reduce CO¬2 with hydrogen, electrical energy or photon energy to produce vehicle fuels.

To achieve this, they will develop nanostructured catalysts that operate using solar or other renewable energy inputs. These will be used in a process that mimics CO¬2 activation in nature - an 'artificial leaf' concept - that effectively reverses the polluting process of burning fossil fuels. The team will collaborate with industrial partners Millennium Inorganic Chemicals, Cemex, Johnson Matthey and E.ON.

Dr Williams, of Imperial College London, says: "The key economic issue lies in decreasing the energy required for the processes. We hope to achieve this by developing new, highly active metal/metal oxide nanostructured catalysts, which offer superior performance."

Carbon lock-in

The Universities of Bath, Bristol and the West of England are working together to produce materials that can remove CO¬2 from the atmosphere and lock it into useful products.

At the heart of the project, led by Dr Frank Marken at the University of Bath, will be a one-step process that links catalysts directly with a novel CO_2 absorber, and is powered by solar or an alternative renewable energy source. The resulting 'carbon lock-in' products include polymers, carbohydrates or fuels.

Dr Marken says: "Current processes rely on using separate technology to capture and utilise the CO_2, which makes the process very inefficient. By combining the processes the efficiency can be improved and the energy required to drive the CO_2 reduction is minimised."

The projects are part of Research Councils UK (RCUK) cross-Council programme 'Nanoscience: through Engineering to Application'. www.rcuk.ac.uk/nano

As part of the selection process, researchers were asked to consider potential environmental, health, societal and ethical concerns that may result from the innovation process. Using this responsible innovation approach, the projects all recognise that the solution to one problem should not create another.

The research will benefit a range of UK industries including companies that emit carbon dioxide in significant quantities, such as power suppliers, steel and aluminium manufacturers, fuel companies and fuel users.

The new technologies and materials produced by the research could

create a new branch of manufacturing with worldwide distribution of carbon capture devices, and a new mechanism for carbon credit trading.

Last week the Department for Business Innovation and Skills published a cross-departmental strategy, 'UK Nanotechnologies Strategy: Opportunities Ahead', which stated that the global market in nanotechnologies is expected to grow from US$2.3 billion in 2007 to US$81 billion in 2015*.

More information: * Nanomaterials and Markets 2008 - 2015, Nanopost, quoted in Nanoscale Technologies Strategy 2009 - 12, Technology Strategy Board, September 2009

Provided by Engineering and Physical Sciences Research Council