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CO_2 separation, capture and reuse: a web themed issue

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The global economy associated with exponential population growth has brought about an unprecedented demand for energy in both domestic and industrial settings; we have become dependent on energy for improved living conditions, the manufacture of consumer goods and transportation. Ever since the Industrial Revolution we have devoted much effort to developing advanced technologies for accessing energy almost exclusively from fossil fuels such as coal, oil and natural gas. Although we are successfully exploiting alternative sources of power such as nuclear, solar, wind, hydroelectric (and other) energy, our almost-complete dependence on fossil fuels is still very much in evidence. Indeed, our infrastructure for the extraction, transportation, processing and utilisation of fossil fuels

Mohamed Eddaoudi

Mohamed Eddaoudi was born in Agadir, Morocco. He is currently Professor of Chemical Science and Associate Director of the Advanced Membranes and Porous Materials Center, King Abdullah University of Science and Technology (KAUST), Kingdom of Saudi Arabia. He received his PhD in Chemistry at Université Denis Diderot (Paris VII), France. After postdoctoral research (Arizona State University, University of Michigan), he started his independent academic career as Assistant Professor, University of South Florida (2002), Associate Professor (2008) and Professor (2010). His research focuses on developing strategies, based on (super)-molecular building approaches (MBB, SBB, SBL), for rational construction of functional solid-state materials, namely MOFs. Their prospective uses include energy and environmental sustainability applications. Dr Eddaoudi's eminent contribution to the burgeoning field of MOFs is evident by his selection in 2014 as a Thomson Reuters Highly Cited Researcher.

Leonard J. Barbour

Len Barbour obtained his PhD at the University of Cape Town where he investigated thermodynamic and structural aspects of solvate formation and decomposition. He then undertook a postdoctoral fellowship at the University of Missouri-Columbia, where he continued to pursue his interest in supramolecular chemistry. At present he holds a South African Research Chair in Nanostructured Functional Materials at the Department of Chemistry and Polymer Science, University of Stellenbosch, South Africa. His research interests encompass the study of structure–property relationships in crystalline materials, with specific focus on porous materials for the selective storage, separation and sensing of gases.

is highly developed, relatively convenient and economically viable. Nevertheless, it has become increasingly self-evident that our continued use of fossil fuels is not sustainable – two critical problems that can no longer be ignored are that (i) fossil fuel resources are dwindling, and (ii) CO_2 emissions from fossil-fuel combustion are adversely affecting our climate. Since it is now commonly acknowledged that these issues will become even more acute over the next few decades, the quest for alternative, viable and clean sources of energy has been identified as one of the grand challenges of the 21st century. In the meantime, we will still be using fossil fuels for the foreseeable future and the need to mitigate the environmental implications of CO_2 production is highly topical, particularly with regard to CO_2 capture with a view to its separation, sequestration, conversion or utilisation.

Fuel cells that utilise hydrogen and oxygen to produce water and electricity have been identified as a tantalising clean alternative to the use of fossil fuels. However, most of the world's hydrogen is still produced from fossil fuels, with CO_2 and other gases as by-products. The much-publicised "hydrogen economy" precipitated substantial research efforts aimed at developing new types of porous materials to solve the problems associated with hydrogen purification and storage. When it became apparent that hydrogen storage in synthetic materials is a formidable challenge, emphasis shifted to the use of these materials for CO_2 separation, capture and remediation.

The last decades have witnessed an exponential and alarming CO_2 rise in the atmosphere. Due to the critical necessity to reduce CO_2 emissions, economic and efficient CO_2 capture technology is a top research priority in both academia and industry. However, current methods to capture CO_2 are based on processes that are both costly and energy-intensive.

Until relatively recently, porous materials with potential applications for gas storage, sensing, separation and catalysis have consisted mainly of conventional activated carbons and zeolites. However, exciting breakthroughs have been made within the past two decades with the advent of new classes of porous materials, including polymers, organic molecular crystals, covalent organic frameworks and metal–organic frameworks. Much emphasis has been placed on the design of functional materials, and the application of advanced experimental and theoretical methods in order to elucidate structure–property relationships. This web-themed issue of *Chemical Communications* features a cross-section of the cutting-edge basic research that is currently focusing on the problem of carbon capture.