# MAKING A MATERIAL DIFFERENCE TO THE OIL AND GAS INDUSTRY

**In 2012, BP brought together four world leading universities to create an international centre of excellence in advanced materials research. Six years on from its launch, we take a look at some of the innovative research to come out of the BP International Centre for Advanced Materials (BP-ICAM).**

Materials underpin many key operations within the oil and gas industry, from upstream exploration and production, through to downstream refining, petrochemicals, fuels and lubricants. Recognising the critical dependence of materials on their sector, BP set up the BP International Centre for Advanced Materials (BP-ICAM) in the autumn of 2012 with an investment of $100 million. The BP-ICAM, a collaboration between BP and the Universities of Manchester, Cambridge, Illinois at Urbana-Champaign and Imperial College London, combines game-changing capabilities in areas such as structural materials, corrosion, separations, surfaces, deposits, imaging, modelling and self-healing materials. These four academic partners and BP work collaboratively and seamlessly across their organisational boundaries. BP provides the industrial context and expertise to ensure that their research will directly tackle materials challenges in the oil and gas industry.

## A Unique Partnership

The BP-ICAM conducts fundamental and applied research in materials science and engineering to solve business challenges for BP and the oil and gas industry. Each academic partner brings a unique set of skills and expertise to the partnership. The University of Manchester, the Hub for the BP-ICAM, is well renowned for world-leading expertise in structural materials, imaging and characterisation, and functional materials. This materials expertise is underpinned by their capability in whole life design, materials performance in extreme environments, and corrosion engineering. The University of Cambridge makes key contributions to the BP-ICAM in a number of important areas such as the development of new alloys, smarter surfaces for anti-fouling, engineering, and chemistry. Cambridge also has world leading expertise in surface science, including state of the art modelling and surface analysis methods which are used to understand the surfaces, materials and environments present in oil and gas operations.

The University of Illinois at Urbana–Champaign has world leading expertise in surface science, biosciences, materials characterisation, coatings, wear resistant self-organising materials, and materials that can autonomously indicate damage and heal themselves. They are developing new materials that are valuable in improving the safe operation and reliability of components and systems where routine inspection is difficult. Imperial College London has distinctive expertise in membranes and other adsorbent technologies for separations, and also has strong capability in the molecular modelling of materials across time and length scales. In addition, its skills in surface science and characterisation, tribology, corrosion and earth science are supporting several BP-ICAM research projects.

## Membranes for More Efficient Separations

The separation of chemicals is fundamental to a very large number of industrial processes and the use of chemical separation and purification is extremely energy intensive. According to Nature, 10 to 15% of all energy consumed globally is used in chemical separation processes. Researchers at the BP-ICAM are taking on the challenge of creating more efficient membranes with the potential for new applications.

Through experiments and mathematical modelling, a team of scientists and engineers at Imperial College London, led by Professor Andrew Livingston, are developing a new understanding of the structure and function of polymer membranes for reverse osmosis. Understanding the operation of membranes at a fundamental level could lead to improvements in the efficiency of water desalination processes. A sister project at the University of Illinois at Urbana Champaign, led by Professor Benito J. Mariñas, is researching membranes for waste water clean-up. The Illinois team are developing novel polymer membranes that will be selective, letting water pass through and rejecting organic contaminants that are present in very low levels.

## Smart Coatings to Prevent Corrosion

According to NACE International, the worldwide corrosion authority, it is estimated that the global annual costs related to corrosion across all industries are greater than $2.5 Trillion. The oil and gas industry uses coatings to protect its steel assets from corrosion but if this coating is damaged or degrades, there is no protection of the underlying metal substrate and the steel will

*BP-ICAM researchers at The University of Manchester are using the latest cutting-edge 3D imaging techniques to understand the behaviour of materials in real time.*

*BP-ICAM researchers at Imperial College London have developed a polymer membrane 10,000 times thinner than a human hair, with the potential to filter substances much faster than commercial membranes.*

begin to corrode.

BP-ICAM researchers at the University of Illinois at Urbana-Champaign led by Professors Nancy Sottos, Jeffery Moore and the late Scott White have worked with BP to lead the way in the development of novel self-healing and smart coatings. The interdisciplinary team at Illinois have created self-healing polymer materials which not only heal but protect against corrosion, with potential applications for the oil and gas, energy, aerospace, and transport industries.

## Developing New Lubricant Additives

Over the past few years, increasing demand for higher fuel efficiency, coupled with the introduction of new materials in engines, has driven demand for a new generation of additives for the lubricants used in the automotive, shipping, and industrial sectors. Work by BP-ICAM scientists is helping BP's Castrol lubricants brand prepare for this future of ever-evolving legislation and shifting consumer demands, and to create efficient, more sustainable additives.

*The BP-ICAM is developing new chemistries to deliver new lubricant additives and materials to mitigate wear.*

Fuel efficiency is one of the primary drivers of the BP-ICAM research. Engines are getting smaller and working harder, creating greater demands on the lubricant. Developing an enhanced understanding of the behaviour of current additives at the molecular level through BP-ICAM is helping Castrol to remain competitive in the global lubricants market.

## A Glimpse into the Future

Six years into the partnership, the BP-ICAM is already delivering real business value to BP and providing solutions to global challenges which have challenged the oil and gas industry for decades. Its cutting edge science and engineering research is being applied to BP's operations in Upstream and Downstream. BP's Group Technology business development team is also helping to commercialise the innovation coming out of BP-ICAM. The BP-ICAM aims to remain at the cutting edge of materials science and engineering over the next decade and beyond, with new research areas of particular interest including bio-inspired materials, computer aided materials design and multifunctional smart materials.

For more information, visit: www.icam-online.org

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