https://doi.org/10.1595/205651318X15300203324808 Johnson Matthey Technol. Rev., 2018, **62**, (3), 257–258

JOHNSON MATTHEY
TECHNOLOGY REVIEW
www.technology.matthey.com

Guest Editorial

Surface Chemistry and Coatings at Johnson Matthey

Johnson Matthey has a long history and track record of designing and supplying specialist coatings into a wide range of application areas and substrate types. A common theme is the requirement to deposit precise amounts of materials. This is key for expensive platinum group metals and for the resulting coating to provide a function such as catalytic, conductive, protective or optical.

Building Insight

Scientists in Johnson Matthey have built up insight into chemical interactions and speciation at the interfaces of solids, gases and liquids. This knowledge has been used to improve processes, construct new and improved catalysts and surface coatings and enhance manufacturing capability.

Key to the understanding is characterisation of the surfaces and interfaces across the length scales: from nano (atomic) scale, through the micron ranges to macro scales on the mm and cm lengths. On the nanoscale, chemical bonds and molecular interactions are probed *via* a range of electron optical techniques such as high-resolution transmission electron microscopy (HR-TEM), scanning electron microscopy (SEM), electron probe microanalysis (EPMA) and X-ray photoelectron spectroscopy (XPS), all used widely in Johnson Matthey.

Materials of interest come in phases from crystalline through to amorphous and combinations thereof. Having the capability to characterise both using X-ray diffraction (XRD) and solid-state nuclear magnetic resonance (SSNMR) coupled with electron adsorption spectroscopy techniques gives us a full picture of solid state materials in current and future products. Specific areas of study have been, for example, surface or bulk crystallisation in glass phases for Johnson Matthey's automotive glasses and metal-metal oxide support interactions in catalytic transformations both in the gas and liquid phases.

Of particular interest to Johnson Matthey is investigation of catalytic function in real time under reactive gas/liquid environments. Cells that can be inserted into spectrophotometers or used with some of the analytical techniques mentioned above have led the way to *in situ* data acquisition giving rise to product understanding at the catalytically active sites. This is key to being internationally competitive for activity and selectivity of desired products and ensuring the catalyst minimises byproducts that require removal from the reaction streams, thus driving towards more sustainable products and processes.

A Track Record of Success in Coatings

Some of the earliest coating products in Johnson Matthey came from the Hatton Garden site in London, UK, around the 1920s. These were in the form of inks and pastes to produce decorative precious metal films, mostly involving gold. The inks would contain finely divided or micronised gold powders or soluble gold precursors in organic media comprising natural resins and organic solvents. The inks were applied by screen printing onto ceramic or glass and fired to elevated temperatures to remove the organic fragments and reveal bright lustrous films.

As electron optical techniques became more informative, they allowed the gold film structure and bonding mechanisms onto ceramic or pottery type substrates to begin to be elucidated, giving insight into bonding mechanisms of gold onto metal oxides and allowing improvements to be designed. Surprisingly, from these complex ink mixtures precise gold coating thicknesses could be obtained by a combination of careful control of ink rheology and an intimate knowledge of screen printing technology. These early products were the forerunners of today's specialist surface coatings.

Latest Research

The research is continuing today. In this issue further examples can be seen from the contributing authors, namely: *in situ* spectroscopic studies of methanol steam reforming catalysis probing both surface and bulk (1); coating technologies for continuous flow reactors (2); using SSMNR studies to again determine surface and bulk structure of catalytic supports (3); or using molecular probes to determine acid sites in zeolites (4). All of these papers enhance our knowledge of surface properties and advanced coatings technologies to deliver active species where they are most wanted and effective.

Enjoy your read.

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