These materials have volume resistivity of 1×10^{13} to 1×10^{14} Ω cm. Thus, agitation in nonaqueous solutions containing organic substances results in a significant buildup of excess electric charge over leak charge. This can result in static charges of several tens of thousand or hundreds of thousand volts that could lead eventually to damage or explosion of the glass-lining materials, even if the glass-lined devices are electrically earthed. It is standard practice to embed or wind platinum or tantalum wires in or around the glass lining materials, but such treatment primarily has a local effect and is inadequate.

An example in (2) describes how the addition of 0.5 wt.% of platinum fibre of diameter 0.5 μm and length 2 mm to porcelain enamel reduced the volume resistivity to 1.3×10^3 Ω cm. This can effectively prevent electrostatic buildup. If, however, platinum powder is used, 20 wt.% of platinum powder must be added to achieve a volume resistivity of 4.7×10^3 Ω cm.

A container that had to be glass-lined every three months to repair damage caused by static discharge was replaced with a container made of electrically conductive enamel, using the said method. After five years, the container remains serviceable and exhibits no problems.

References

1 S. Shimizu, K. Mori and E. Sakuma, *Japanese Appl.* 11-226,627; 1999

2 Y. Iizawa and M. Akazawa, *Japanese Appl.* 10-081,544; 1998

The Author

Kenya Mori is a Chief Researcher at TKK's Technical Center in Kanagawa. His main professional interests are in developing precious metals for industrial materials.

Iridium Oxide Sensors for Industrial Lubricants

Engine oil lubricates and protects engines against wear. Engine oils comprise a base oil and additives (1) to improve the performance and long term stability of the oil, such as antioxidants, antiwear and corrosion inhibitors, detergents (surfactants), dispersants and viscosity modifiers. The working life of any engine oil or industrial lubricant may depend on its base oil formulation and the additives, and the engine size and its operating conditions.

In use, engine oils change chemically due to oxidation and contamination by ethylene glycol, fuel, soot, water, worn metal, etc. Industrial lubricant is degraded by exposure to high temperature, air, alcohols, glycol, NOx and water. The additives interact with both the oil contaminants and oxidative by-products of oil degradation to render them harmless.

However, continuous monitoring of the chemical condition and degradation of the oils, by an online sensor to indicate the necessary oil changes, could make engines more efficient and safer. Engine oil breakdown is closely related to the level of acidity: increase in total acid number (TAN) (oxidative degradation), and level of basicity: decrease in total base number (TBN) (degradation of antioxidants, dispersants and detergents), in the oil.

Acidity/basicity measurements by potentiometric testing is standard practice and iridium oxide (IrO_2) shows promise for measuring pH range and sensitivity, ion and redox interference, and hysteresis effects. Now, a team from Case Western Reserve University and the Lubrizol Corp., U.S.A., have run tests with chronopotentiometric (CP) sensors having IrO_2 as working electrode, and have detected TAN and TBN in a diesel oil (2). The sensors were both conventional (a macro-scale) and miniaturised (microelectromechanical system (MEMS)) devices.

In diesel oil drains the sensors showed good correlation between the TBN and TAN numbers and their individual voltage outputs. Conventional IrO_x sensors displayed greater sensitivity to changes in TAN and TBN than the MEMS sensors.

A CP sensor (a "melt Ir oxide sensor") consisting of an Ir wire electrode, oxidised in a Li_2CO_3 melt to form a Li_xIrO_y film on its surface, had a large increase in sensitivity due to the Li_xIrO_y responding to carboxylic acids, and also to esters through a second surface reaction catalysed by Li.

The sputter-formed CP sensor gave a better response to oxidative degradation of oil due to its higher sensitivity to ketones and carboxylic acids. The differences in reaction mechanisms between the Ir oxide and the components of the solution gave opposite responses to changes in basicity in aqueous and non-aqueous systems. However, as long term stability and durability is a problem it is concluded that work is needed to improve design and fabrication.

References

1 A. J. J. Wilkins, *Platinum Metals Rev.*, 2003, **47**, (3), 140

2 M. F. Smiechowski and V. F. Lvovich, *Sens. Actuators B: Chem.*, 2003, **96**, (1–2), 261