APPLICATION NOTE

Screening for Superficial Contaminants using the benchtop MiniSIMS

Mini SIMS

MiniSIMS analysis of solid surfaces is a very quick way to reveal trace amounts of organic or inorganic surface contaminants.

- Analysis of Superficial or Sub-Monolayer Contaminants
- Detection of Elemental Components
- Library Matching to Identify Organic Species

The cleanliness of a surface is a major factor in determining how well it performs its intended function. For example, contamination will degrade the strength of subsequent adhesive bonding to the surface, including problems of poor adhesion of paint or other coatings. The problem may not be apparent until later in the production process, or until the product fails after it has been in use for a short period. Early identification and elimination of contamination issues is therefore vital.

Particulate contamination is often easily visible, and can be analysed by many techniques including SIMS. However, when the contamination is present as a surface film rather than as a particle, it may be only a monolayer in thickness and invisible to the naked eye. Thin film contamination of this type is frequently organic rather than inorganic in nature, and this means that a mass spectral approach to analysis is ideal.

It is possible to try to dissolve the contaminant and perform a bulk analysis, but SIMS offers a more convenient and direct method to identify surface contamination in situ. In addition, focusing the primary ion gun gives a spatially resolved analysis that allows the exact location of the contaminant to be established.

This application note demonstrates how the MiniSIMS provides a fast method to detect and distinguish a range of common organic contaminants. The mass spectra not only identify the component elements, but the higher mass molecular ions provide a characteristic "fingerprint" for the material.

See overleaf for more detailed information.

SCIENTIFIC ANALYSIS INSTRUMENTS

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The figures show three static SIMS spectra acquired from three contaminated metal surfaces. The fast analysis speed of the MiniSIMS allows spectra such as these to be acquired in less than half a minute.

Mass spectra show both inorganic and organic constituents, giving information about molecular structure as well as elemental composition. In the case studies shown here, the elemental information gives some initial clues about the nature of the contaminant, but the higher mass organic information allows a much more specific identification.

These are the negative SIMS spectra, and in each case there is a corresponding positive SIMS spectrum. For full identification, both spectra would normally be analysed in combination, but for reasons of limited space only the negative spectra are considered.

The first spectrum (figure 1) was matched to a high-performance cutting fluid. This features a relatively low oxygen to carbon ratio, reflected in the peak ratio for CH and O^- at low mass. Even when the molecular weight is above the mass range of the MiniSIMS, characteristic fragment ions in the mass range m/z = 100 to 300 are seen, and these can be used as a specific "fingerprint" to detect the presence of this fluid.

The second spectrum (figure 2) is from a fluorinated lubricant additive, and now F is the dominant elemental peak at low mass. The higher mass peaks (with the exception of the peak at m/z = 61) are carbon/fluorine cluster ions. The relative ratio of these C_xF_y peaks alters between fluorocarbons and this effect can be used to deduce further information about the molecular structure.

The final spectrum (figure 3) is of a cleaning and degreasing agent. Once again the lower range of the spectrum identifies the elements that are present, in this case including sulphur from a sulphonated surfactant. Chlorine is notably absent from the spectrum. The higher mass range again provides a way to obtain a more specific match to a particular cleaning agent.

A library of common materials is supplied as an option for the MiniSIMS. Alternatively the user can generate reference spectra for individual materials used in their own production process, and use these for comparison with detected contaminants.

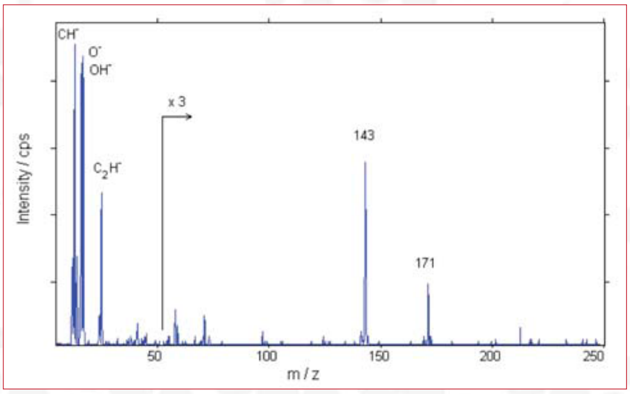

Figure (1) SURFACE SPECTRUM REVEALING PRESENCE OF A CUTTING FLUID

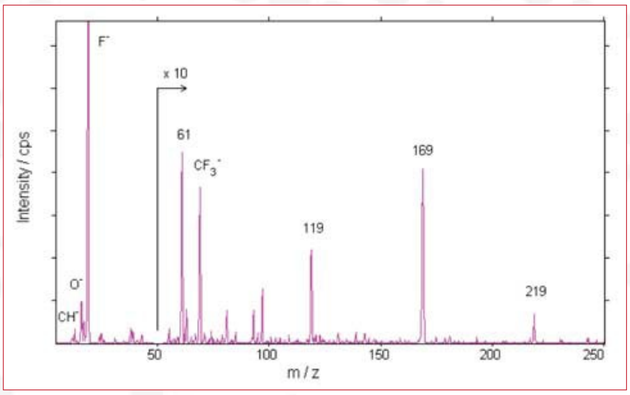

Figure (2) SURFACE SPECTRUM REVEALING PRESENCE OF A LUBRICANT ADDITIVE

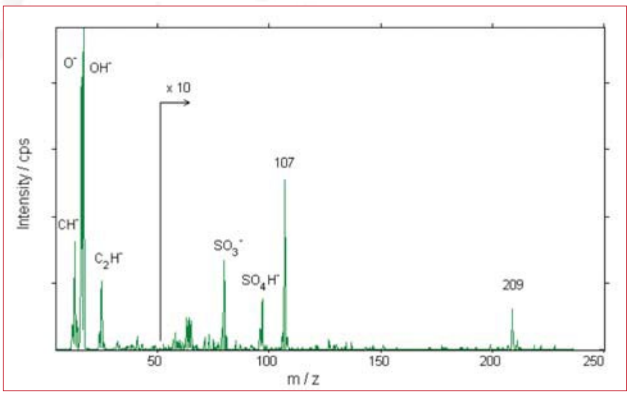

Figure (3) SURFACE SPECTRUM REVEALING PRESENCE OF A METAL CLEANING AGENT