Application Note: 31039

Chemical State Imaging of Carbon Fibers on PET

Key Words

- Surface Analysis
- Chemical State Imaging
- Co-axial Charge Compensation
- High Resolution X-ray Photoelectron Imaging
- High Sensitivity

X-ray photoelectron spectroscopy (XPS) is one of the most popular techniques for the analysis of polymer surfaces. Its power lies in the fact that it can identify quantitatively not only the elements present at the surface, but also their chemical states.

The high performance of the Thermo Scientific ESCALAB 250 results from the unique combination of fast parallel imaging, pioneered by Thermo Fisher Scientific, and a microfocusing X-ray monochromator.

Accurate sample positioning is essential if the highest image resolution is to be obtained. The design of ESCALAB 250 ensures that sample alignment is both fast and efficient, so that high resolution images can be obtained very quickly.

This example illustrates the combined use of parallel imaging, high energy resolution, excellent sensitivity and optimum charge compensation.

This application shows how the ESCALAB 250 can be used to produce high resolution chemical state images from a sample consisting of carbon fibers on a polyethylene terephthalate (PET) substrate.

This is a particularly challenging sample for XPS imaging studies because:

- The substrate is an insulator while the fibres have some conductivity. Differential charging, if not properly controlled, can therefore affect peak shape making good images impossible to obtain.
- The sample is not flat, contributing further to the dangers of differential charging.
- The fibers are only 10 µm in diameter, requiring an XPS instrument with the highest spatial resolution.

The ESCALAB 250 uses a coaxial electron flood gun to control surface charging. As the flood electrons approach the surface along the axis of the analyzer lens, shadowing is minimized and differential charging is removed. The very high spatial resolution, inherent in parallel imaging, combined with effective charge compensation easily enable rapid, high quality, chemical state, imaging of both fibres and substrate.

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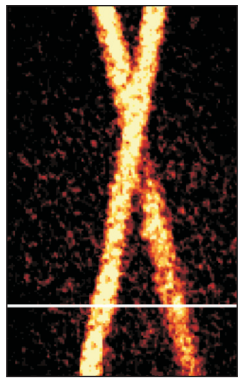

Figure 1: C 1s image of the carbon fiber. Image collected in 5 minutes.

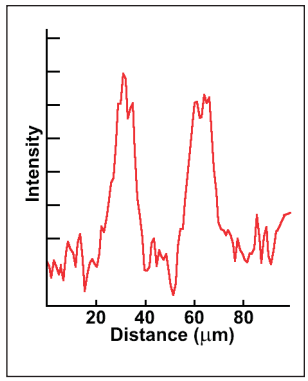

Figure 2: A line scan extracted from the C 1s image of the fiber, showing that the spatial resolution in the image is better than 2 µm.

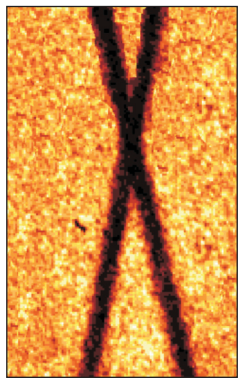

Figure 3: C 1s image of the PET substrate. Image collected in 5 minutes.

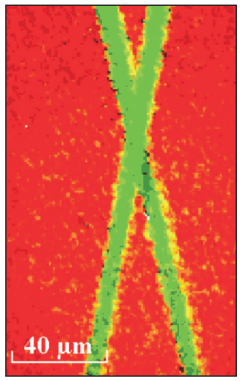

Figure 4: Colour overlay image, showing the two C 1s images.

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