Application Note: 31091

K-Alpha: Accurate Feature Alignment with Unique Reflex Optics

Key Words

- Surface Analysis
- Sample Illumination
- Sample Viewing

Introduction

Amongst the unique features of the Thermo Scientific K-Alpha is its system for sample illumination and viewing.

An XPS instrument having a small spot X-ray source must have a means for accurately aligning the feature to be analyzed with the analysis position. On K-Alpha this is done optically with a system involving three cameras, the output of each being displayed using the Avantage data system: The three cameras are:

- The Platter View camera
- The Live Reflex Optics camera
- The Height Setting camera

It is equally important that the samples should be properly illuminated so that the viewing system can be used effectively.

The purpose of this document is to describe how the sample viewing system is used and to illustrate the effectiveness of the sample illumination system.

Platter View

While the sample holder is in the system loadlock being pumped, an image of it is recorded, an example is shown in Figure 1. At this time, the analyst can choose the positions from which XPS spectra will be taken and define the measurement conditions (energy range, pass energy step sizes etc.). By doing this as the samples are being pumped the analysis can begin as soon as the system transfers the samples to the analysis chamber. Analysis time is being used most efficiently, helping to maximize throughput.

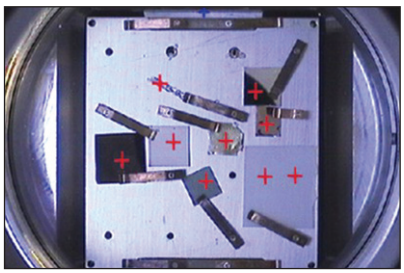

Figure 1: Image of the sample holder in the K-Alpha loadlock, automatically collected as the sample holder is being pumped. The red crosses indicate the analysis positions chosen by the analyst.

Live Reflex View

For most XPS systems, the designers must compromise between a system that maximizes XPS sensitivity (by collecting the photoelectrons that leave the sample parallel with the surface normal) or a system in which the sample viewing is along the surface normal making the sample alignment more convenient and more accurate.

On K-Alpha, there is no such compromise, it is designed with the unique Reflex Optics which combine optimum sample viewing with maximum sensitivity. The method by which this is achieved is shown schematically in Figure 2. This arrangement allows the analyst to observe the analysis position throughout the process of analysis.

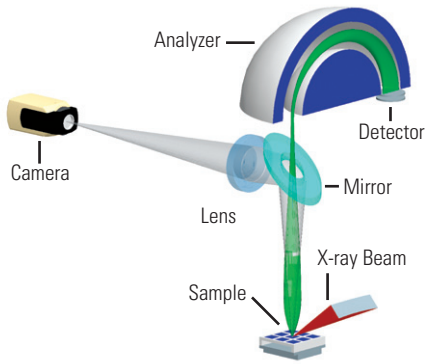

Figure 2: Schematic diagram of reflex optics, showing how a magnified image of the sample can be seen by the camera with the viewing angle normal to the sample plane while photoelectrons are collected along the same direction.

The magnification of the live Reflex View is much greater than that of the Platter View and allows the positions of small area measurements to be selected. Figure 3 shows the live Reflex View of a dental implant in the analysis position. The markings on the image show the area currently being analyzed and the area that will be analyzed next. Not only can the analysis position be selected from this view but the size of the X-ray spot can also be selected and matched to the feature size.

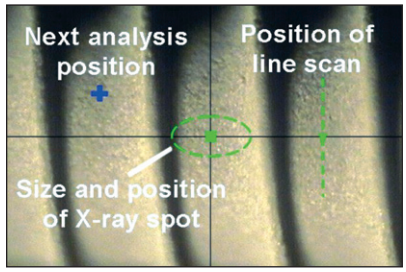

Figure 3: The live Reflex View of a dental implant in the analysis position. The markings show the position of the current analysis and positions that will be analyzed next.

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Sample Height Camera

It is critical in an instrument such as K-Alpha that the sample height is set correctly. If the sample height is incorrect then:

- The XPS sensitivity would not be optimum
- The analysis position would be wrong
- The analysis area would be wrong

For the analysis of uniform surfaces, sample height setting can be accomplished automatically using the XPS signal. For the analysis of samples having small features at the surface, this may not provide a sufficiently accurate result. For these conditions, a third camera is used. This is arranged at an angle to the sample and is focused accurately on the analysis position.

To align a feature with the analysis position, the analyst first positions the feature at the centre of the view generated by the live Reflex Optics camera using X and Y motions of the stage. The view is then switched to the height setting camera and the same feature is centered in the field of view using only the Z motion of the stage (parallel to the lens transfer axis). When the same feature is aligned with the cross hairs of both cameras, the sample is at the correct analysis position.

Figure 4 shows an example of the use of the height setting camera. The same feature can be seen to be aligned with the cross hairs of both the image generated by the Reflex Optics camera and by the height setting camera.

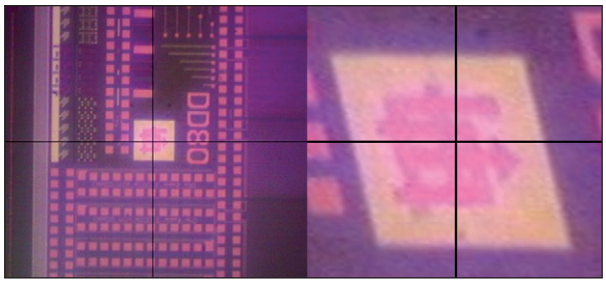

Figure 4: Left image shows a feature collected via the Reflex Optics while the image on the right was collected using the height setting camera. The same feature is aligned with the cross hairs in each image and so the sample is at the correct height.

Sample Illumination

When aligning small features with the XPS analysis position, the quality of the sample illumination is as important as the quality of the optical viewing system. Optimum illumination depends upon the sample type. Highly reflective samples require illumination which is co-axial with the microscope while powders and samples having rough surfaces are best viewed under a more diffuse illumination.

The design of K-Alpha is such that optimum illumination is available regardless of the sample type. A light source positioned within the Reflex Optics is provided and produces co-axial illumination as well as a more diffuse light source positioned within the analysis chamber. The intensity of each light source can be adjusted independently.

Figure 5 illustrates the importance of having the two types of illumination available. All of these images were acquired using the Reflex Optics. The first example in Figure 5 shows a crater in the process of being generated using a 200 eV argon ion beam. The reflective nature of the sample means that the greatest clarity is achieved using illumination that is coaxial with the Reflex Optics. The second example, paper, has a rough surface. For this type of sample diffuse lighting is essential. The third, example, a semiconductor device structure, reveals different features depending upon which of the light sources is used.

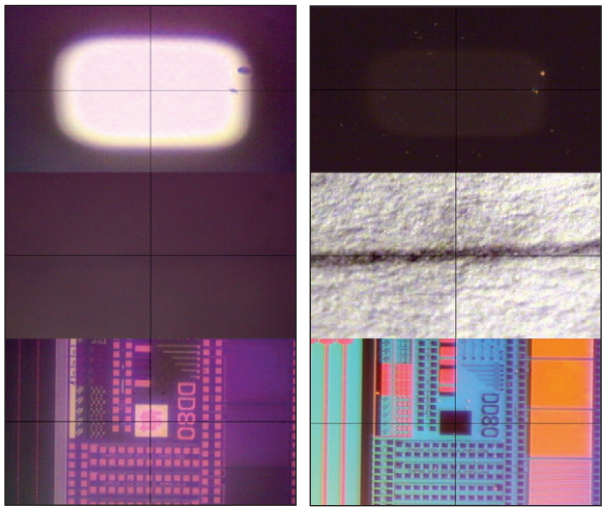

Figure 5: The live Reflex View of three samples each viewed under axial and diffuse lighting conditions. Top: a depth profile crater viewed as it was being formed. Middle: a sample of paper. Bottom: a semiconductor device structure.

Conclusion

K-Alpha is the only XPS instrument to have such an advanced optical system. This system is one of the features that ensures that K-Alpha allows the analyst to produce high-quality data consistently and rapidly as well as having complete confidence that the right area of the sample is being analyzed.

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