

# Rapid XPS image acquisition using SnapMap

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## Introduction

SnapMap technology, available in the Thermo Scientific™ Nexsa™ and K-Alpha™ XPS systems, offers the surface analyst the ability to produce high resolution, large area, XPS images within minutes. To achieve this the sample stage is moved through the stationary X-ray beam so that the X-ray spot is effectively rastered across the selected area of the sample surface. The stage movement is synchronized with the high performance spectrometer which collects snapshot XPS spectra continuously during rastering. The result of this process is the production of a high resolution XPS image of the sample surface with each pixel point representing an individual snapshot XPS spectrum. Unlike scanning the X-ray beam, the stage raster approach keeps the analysis area constant during the analysis, ensuring that all areas of the image have the same definition.

Advantage, the software supplied with all Thermo Fisher Scientific XPS instruments, offers several options in the processing of SnapMap data. Positional data can be pulled from the image to identify key features or areas of interest and defined as analysis points. Spectra from individual pixel points can also be interrogated or averaged for chemical information. The image can also be manipulated using mathematical processes such as PCA (principal component analysis) TFA (target factor analysis) and NLSF (non-linear least squares fitting) to extract significant spectral information from the images.

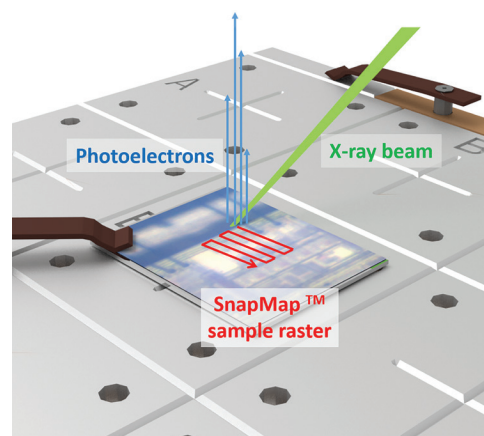


Figure 1: SnapMap in operation

## Using SnapMap

The SnapMap rapid image acquisition feature, common to both Nexsa and K-Alpha XPS instruments, is an incredibly useful tool in the surface analyst's arsenal. The feature is easily included into a regular analytical workflow with minimal cost in experimental time, and that is far outweighed by the benefits that the technique can provide.

While the patented reflex optics of the Nexsa and K-Alpha take care of definition of the area under investigation in most cases, locating sample features that are difficult to see optically can be problematic. Luckily SnapMap can solve the problem. Acquiring a SnapMap of an element specific to the feature, or using a mid-range peak such as O1s if the sample is unknown, will allow the user to identify its position. Features as small as 10  $\mu\text{m}$  can be identified using SnapMap.

The resolution of SnapMap images is limited only by the size of the X-ray spot used to produce the map. This means that the 10  $\mu\text{m}$  X-ray spot of Nexsa offers superior image resolution with no loss of image clarity over large areas of the sample surface. This is illustrated in figure 2.

Avantage provides the user the freedom to define the position of experiments using the reflex optics or from imaging data. This means that the location that specific features are found in SnapMap images can be fed back directly into the Avantage experiment tree as an analysis position.

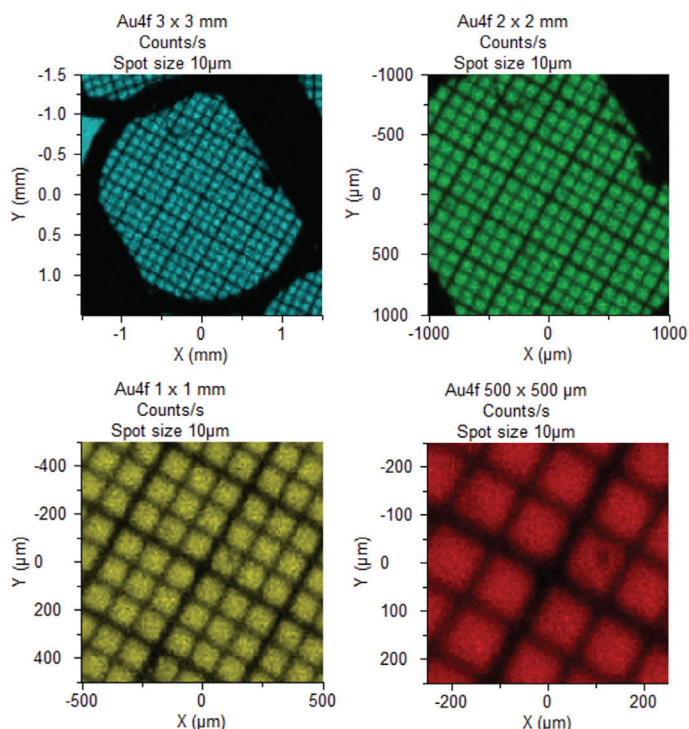


Figure 2: SnapMap XPS images of varied image size of an Au grid deposited onto a Si wafer

As figure 3 shows assigning points for analysis using SnapMap data not only helps the user to ensure ultimate sample alignment, it can also aid in the selection of X-ray spot size based on the size of the feature. This means that the analyst can be sure that XPS signal is sampled from selected feature only. The micro-focused X-ray spot of the Nexsa system allows for features as small as 10  $\mu\text{m}$  can be picked out and analyzed by XPS in isolation. This can include the acquisition of survey scans or high resolution XPS spectra, XPS depth profiling using the Thermo Scientific™ MAGCIS™ ion source, or by further processing of the SnapMap data.

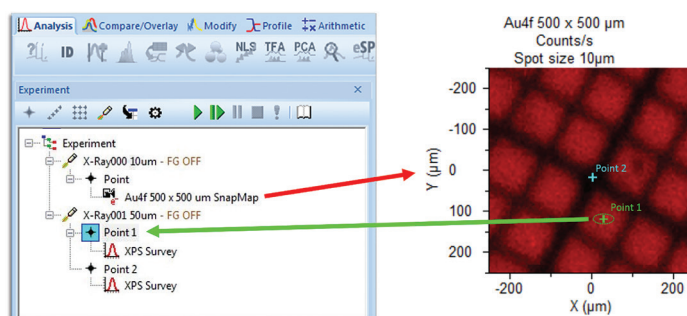


Figure 3: Experimental work flow using SnapMap

## Processing SnapMap Data

Each pixel point in a SnapMap image represents a spectrum meaning that the data can be processed in the same way as conventional XPS spectra. Avantage also offers various mathematical data processing options including NLSF, TFA and PCA, which can all be used to tease useful information from SnapMap datasets and improve the quality of the final image. With multiple elemental SnapMaps the user can deduce positional information about specific features of areas of a sample surface to a very high accuracy. Figure 4 illustrates the SnapMap processing available in Avantage. In the example PCA is used on raw SnapMap data to extract the common peak shapes found in the spectra at each pixel of three SnapMaps. The SnapMaps are automatically replotted by the software to show the relative intensity of the common peak shapes, or principal components by position. These processed SnapMaps can be displayed simultaneously in an image overlay plot providing relative intensities of each of the different elements present in the sample by position.

## Summary

Adding SnapMap rapid imaging to the experimental workflow can aid the analyst in the identification and ultimate experimental alignment of specific or even optically invisible features on a sample surface. Using the rapidly acquired SnapMap as a starting point, components as small as 10  $\mu\text{m}$  in diameter can be located and analyzed quickly and efficiently using the Nexsa system.

Not only an alignment tool, SnapMap images contain XPS snapshot spectra at every pixel point and therefore can be processed and analyzed using many of the same methods applied to conventional XPS spectra. Combining the data processing options of Avantage with the micro-focused X-ray spot of the Nexsa system grants the user the ability to produce high resolution XPS images of large areas of a sample surface within minutes.

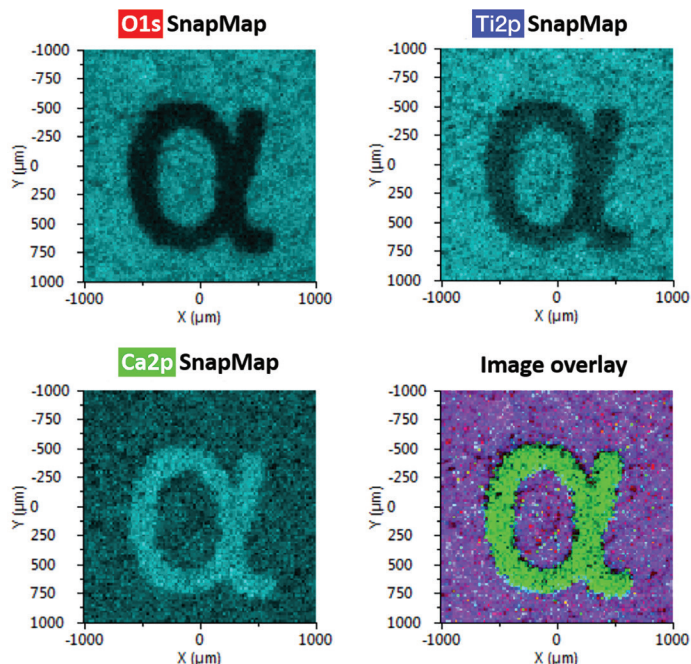


Figure 4: Three different elemental SnapMaps of an “ $\alpha$ ” printed on a Ti substrate processed using PCA and an overlay of the images.

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