Smart Drift Correction

Introduction

Drift correction is often necessary when the time requirement for sample analysis is extended. Apparent sample movement during analysis can cause features to appear distorted or smeared because X-ray mapping and phase analysis are most frequently done by re-visiting pixels on a repetitive or recursive basis. If the sample is drifting during the analysis, the EDS information at any given point may actually show an incorrect combination of elements or phases. Smart Drift Correction, as included in the TEAM™ EDS Analysis System, is extremely useful for X-ray mapping and phase analysis and can also be used for any lengthy analysis including multipoint or linescan collection. Figure 1 clearly illustrates the value of TEAM™ EDS Smart Drift Correction. The uncorrected images are blurry, while the corrected images provide clear detail.

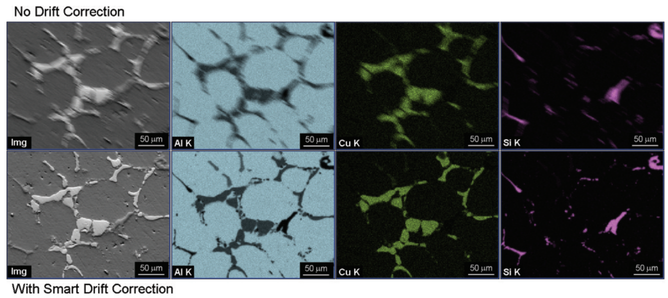

Figure 1. Aluminum alloy image with selected maps. The upper row of images were collected without drift correction and the lower set of maps were collected with TEAM™ Smart Drift Correction. All other conditions for these maps were the same.

What is Smart Drift Correction?

Most drift correction programs require the operator to determine the rate of drift and select a time frame for how often drift is checked and corrected. TEAM™ EDS Smart Drift Correction applies correction with no manual input from the user, with results as good or better than even an expert could achieve. Setup parameters for Smart Drift Correction are either predicted or calculated for the user and are dynamically adjusted during the analysis. Since drift is not constant and can increase and decrease during data collection, adjusting the rate of correction during the analysis is the only way to guarantee that the right amount of correction is used.

Causes of Drift

The movement or apparent movement that leads to drift has a variety of causes. It can be created by sample charging or by a sample adhesive that outgases or is unstable in the microscope. Some volatile samples may change their shape or contrast during the analysis. Even a conductive sample will show charge effects if it is embedded in an insulating mounting material. Mapping fine, delicate features at a high magnification will most often require correction of drift.

Results and Discussion

Conducting EDS analysis on a drifting sample may compromise the integrity of the image, maps, and spectral data. Errors will occur in physical dimension measurements; maps will be distorted; spectral information misinterpreted; and, in some cases, small phases could be missed altogether (Figure 2).

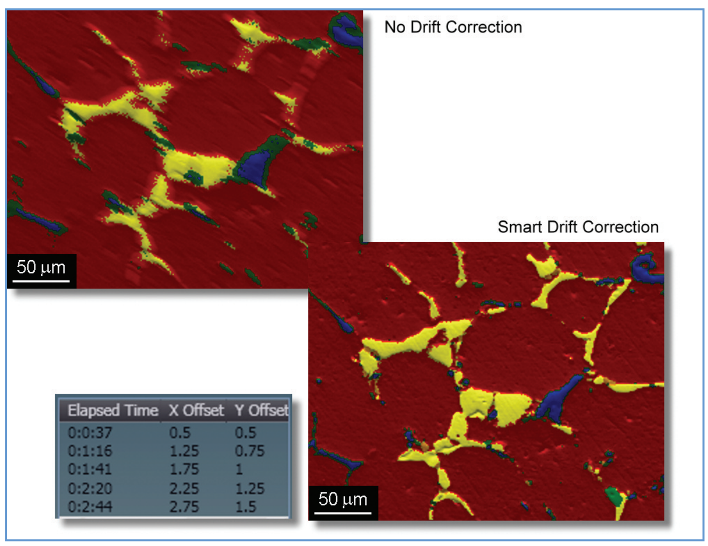

Figure 2. Phase map overlays the same two datasets shown in Fig. 1. Each color represents a separate phase (red = Al, yellow = Cu-Al, blue = Si, orange = Mg-rich). Note that the orange phase could not be found when drift correction was not used. The drift offset table is also shown - illustrating that it is possible to correct for sub-pixel drift.

A common component of drift correction is to collect successive images at a specific time interval or frequency and to locate, or relocate, the same feature in each image (Figure 3). The number of pixels or sub-pixels of displacement are converted to image scanning coordinates and the image and collected data are brought back into proper alignment with previous analyses. This task is facilitated by having good contrast throughout the image or by having an image analysis routine that locates the sub-area of the image that has the highest contrast (Figure 4). It is often not possible to forecast how much the sample will drift or how frequently the drift correlation should occur. TEAM™ EDS Smart Drift Correction determines the rate of drift and makes corrections to the frequency as necessary.

Figure 3. Drift Correction software panel and parameters used during an analysis. In this case the initial drift correction images were collected every 30 seconds. However, after collected images demonstrated that there was drift, the frequency of collection was automatically changed to 15 seconds.

Some samples will be dynamic as imaged. This dynamism can result from a charge and may change contrast or the sample may show a volatility resulting in a change of particle or feature shape. The instability of beam current will also lead to modified contrast during the analysis. In these cases, images should not be correlated to the first collected image but to a more recently collected image. Smart Drift Control monitors the overall drift and optimizes adjustments to the reference image to minimize any apparent movement (Figure 4).

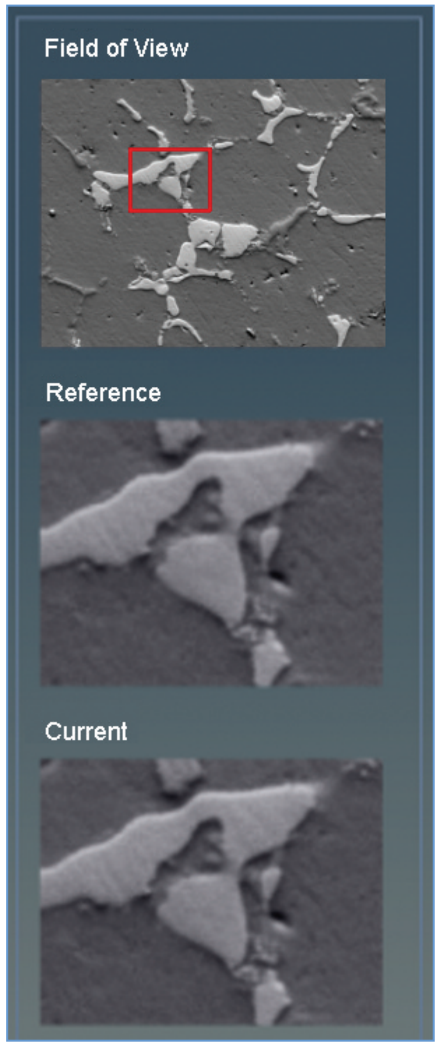

Figure 4. Drift images. The area mapped is shown as the "Field of View" and the red rectangle shows the area of the image that was determined to have the highest amount of contrast. The similarities of the "Reference" and "Current" images show that there has been very little drift in the interval of time represented by these images.

Conclusion

Drift may occur on any sample, compromising analysis results and wasting valuable analysis time. Current drift correction programs require user input for proper set up. Since drift can change dynamically, even the initial set up could be wrong. Smart Drift Correction is the only drift correction program on the market that automatically sets drift parameters and corrects for any change that occurs during the analysis, ensuring the analysis is accurate and completely identifies all elements and phases.