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Post Processing of X-Ray Maps - Theoretical BSE Mapping, Totals Mapping and Ratio Mapping

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Scanning electron microscopy (SEM), wavelength dispersive spectroscopy (WDS) and energy dispersive spectroscopy (EDS), and the combination of these techniques through x-ray mapping (XRM) has become an excellent tool for characterizing the distribution of elements and phases [1].

There is so much more information that can be obtained from full spectrum maps other than just a regions of interest elemental map (ROIM). The full spectrum maps can be processed to determine important information about the microstructure and properties of the material. To obtain a better understanding of a material's chemical and microstructural properties a number of post-processing methods can be employed. This includes generating ZAF corrected quantitative x-ray maps (QXRM maps (Fig. 1). Quantitative x-ray mapping (QXRM) enables reliable quantitative results that can be an order of magnitude better than traditional analysis and is also far superior to regions of interest x-ray maps (ROIM) where low levels of an element or elemental overlaps are present [2]. The use of scatter diagrams, rotational scatter diagrams, pseudo colouring and filtering techniques has been presented before by the authors [2-4]. Other information that can be obtained, which is very important and gives the user even more important information about the microstructure of their sample, is theoretical BSE maps, elemental ratio maps, atomic number-absorption- fluorescence maps (ZAF) and totals mapping.

When generating elemental x-ray maps, the computer can easily calculate the theoretical BSE coefficient by looking at the quantitative data and using this generate the BSE coefficient for each point on the map (Fig. 2). The theoretical BSE map (or image) gives us information on what is going on just below the surface of the sample. We can also ratio the real BSE to the generated BSE to pick up problems such as quantification errors, interaction problems and ZAF correction problems.

Most users are aware that traditional quantitative standards based analysis involves totals in the range (99-101) which gives them an idea of accuracy of the results. This also applies to x-ray mapping. Through x-ray mapping, the totals at each point of the map can be calculated and mapped (Fig. 2). These total maps then give us an idea of the quality of the analysis and also make it easy to determine problem areas within the analysis area.

Elemental ratio mapping is a powerful technique that helps to reveal subtle chemical variations in a sample and is similar to a scatter diagram for these two elements. Scatter diagrams give you correlation between one element and another in the form of an intensity histogram. Whereas, a ratio map between two elements shows the spatial distribution of this correlation (Fig. 3). Ratio maps can also be created from different combinations of elements and from the different background regions near elements of the spectra. Background ratio mapping near absorption edges can aid in determining absorption differences and is very powerful.

This paper will be discussing elemental mapping, quantitative elemental mapping and a number of post-processing methods such as is theoretical BSE maps, elemental ratio mapping and totals mapping all of which aid in obtaining a better understanding of a material's properties.

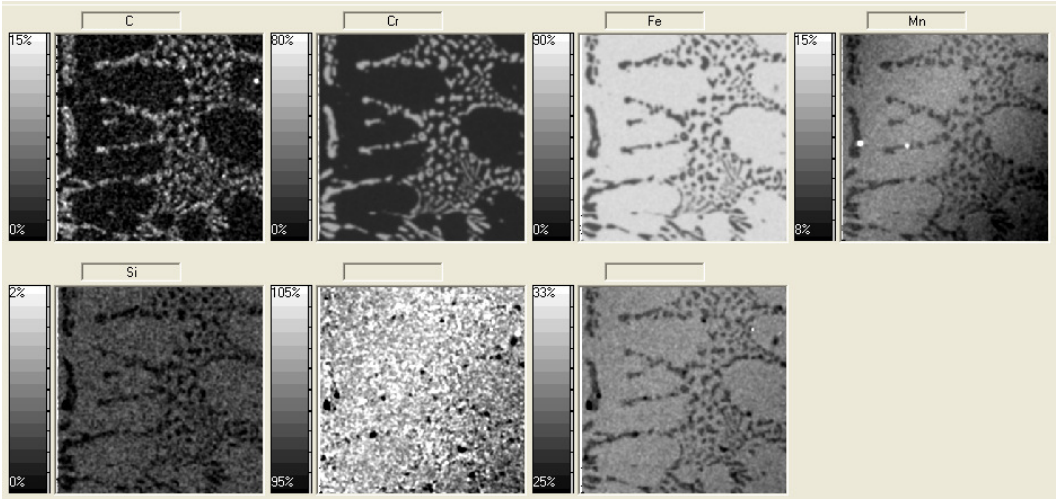

Fig. 1. Combined WDS/ EDS quantitative XRM's of a white cast iron. Carbon and manganese mapped with WDS detector. Map collected at 20keV, 256x256 pixels and 2 hours. HWOF=100μm.

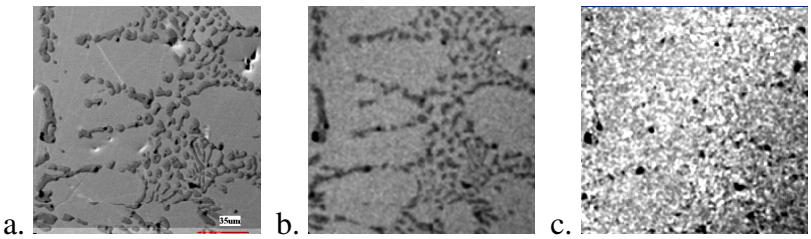

Fig. 2. a) BSE Image, b) Theoretical BSE and c) Totals x-ray map showing 95 to 105 wt% range. Note the diagonal deterioration due to WDS spectrometer defocus for Mn (HWOF=100μm).

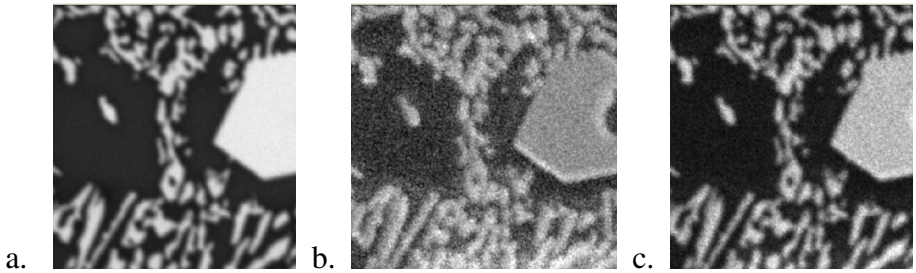

Fig. 3. a) Chromium x-ray map, b) ratio map of carbon to chromium (C/Cr) showing changes around the eutectic carbides and c) WDS carbon x-ray map.

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