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Phase Analysis on Specialty Brass Alloys

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Specialty brasses are very common in many engineering applications. As a non-ferrous alloy it is generally resistant to salt-water corrosion, can be made to have excellent mechanical properties and high wear resistance. Although the basic material is brass (copper-zinc alloy) it is alloyed with variable trace and minor elements to give it the desired properties. These additives tend to form intermetallic compounds, finely dispersed through the material. Improvements on the properties of such materials is a continuous research topic, both in academic and industrial laboratories. Scanning electron microscopy (SEM) and energy dispersive X-ray spectrometry (EDS) are the most commonly used tools, closely followed by wavelength dispersive spectrometry (WDS) and electron backscatter diffraction (EBSD).

One of the alloys that have been investigated is CuZn37MnAl2PbSi, often better known as material number CW713R [1]. This brass contains around 60 w% copper and 37 w% zinc, and is then alloyed with traces of manganese, nickel, aluminium, lead and silicon, although other traces below 0.5% can be found as well. Investigating the intermetallic compounds in this alloy can be very interesting: these compounds tend to be small (several microns in diameter) but can show interesting phase variations even within those small compounds.

SEM with back-scatter electron imaging is as usual the first step in the characterization of a sample, quickly followed by qualitative and quantitative spectroscopy. But the complexity of the intermetallic compounds often require a mapping technique to properly display the elemental distribution within those compounds. Because of the size of these compounds (sub-micron to several micron), and the even smaller compositional variations, analysis often needs to be done at lower voltages. See figure 1 for a net-intensity quantitative X-ray map at 4 kV accelerating voltage. Note the brass matrix is not homogeneous but has Cu rich veins running through it.

With several elements close together elemental maps can be quite confusing, and require extensive explanation to non-experts. To improve the understanding of the elemental maps it can make sense to convert them to a phase map: a single map where each phase gets his own color, immediately displaying the results in a single picture. The preferred route for this is to first process the dataset with a principal components analysis technique, to find out what phases are present in the sample. Then for each pixel in the dataset it is determined which phase most closely agrees with the spectrum at that pixel. See figure 2 for a phase map containing the 4 most dominant phases. Calculated from the measurements used also for figure 1.

Modern techniques like low-voltage analysis, quant-mapping, principal component analysis and phase mapping can significantly improve our understanding of non-ferrous metals, and create a way to further improve the properties and the manufacturing techniques of these materials.

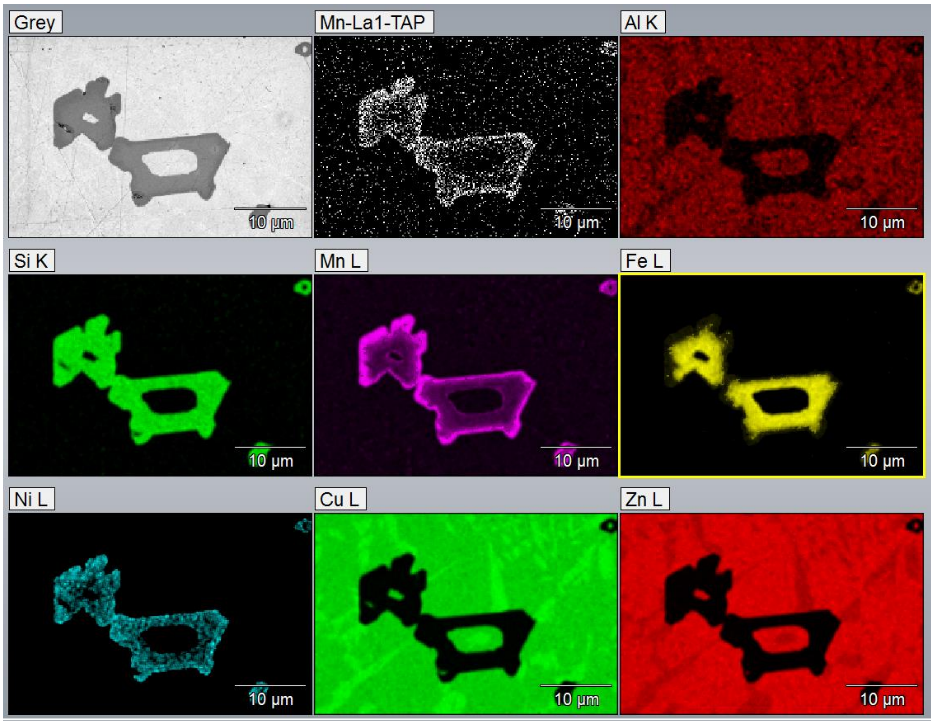

Figure 1. Net intensity quantitative elemental map at 4 kV

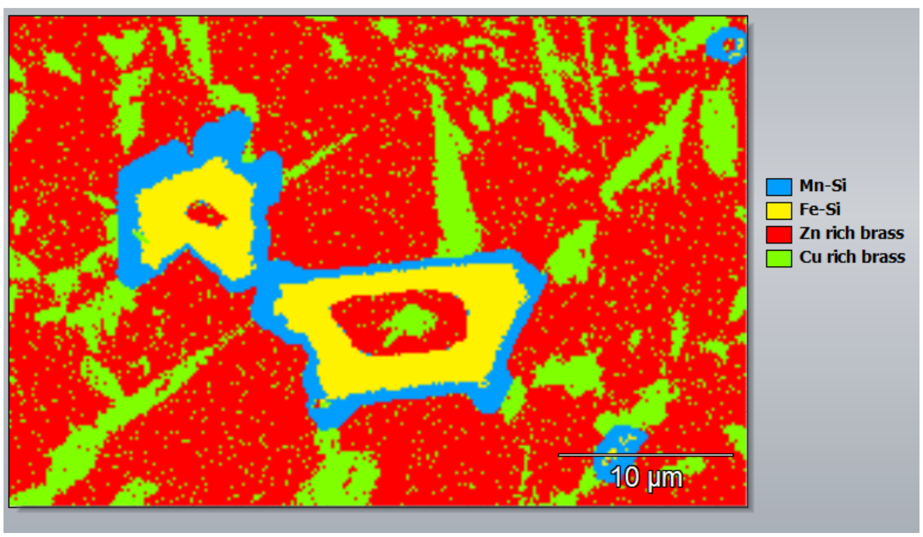

Figure 2. Phase map showing the 4 major phases in an intermetallic compound and its matrix.

[1] Data sheet CW713R: check for example this [Link to PDF datasheet]

References

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