1.9.15. MICRO STRUCTURAL ANALYSIS OF $AlSi_6Cu_4$ USING QUANTITATIVE COMPUTED TOMOGRAPHY METHODS

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Today, microstructural analysis of metall alloys is usualy done by preparing cuts through the object and subsequent light-optical-microscopy (LOM) or secondary electron microscopy (SEM) examination. Initially, this destructive method allows only 2-dimensional cut views, while a 3-dimensional volume generation involves the time consuming and possibly inaccurate preparation of multiple cuts and the following fusion to a 3-dimensional data set. Upcomming new methods like focused ion beam (FIB) tomography allow already a user friendly, but still time consumming 3D analysis of microstructure on a very fine scale, but the investigated volumes are still very small. Recent developments in the field of X-ray imaging, including detector and X-ray production technologies, allow an increasing spatial resolution. Especially micro focus X-ray tubes with a focal spot size of approximately 1 micrometer in combination with high geometrical magnification allow 3D computed tomography (CT) volume images with voxel sizes of less than 1 micrometer. Actually this method allows the investigation of microstructures down to a size of a few microns in a representative volume of about $(2\ mm)^3$.

From this reconstructed volume, information characterizing the microstructure like dendrite length or secondary dendrite arm spacing can be evaluated independent of the probe orientation. Using this 3D CT Method, the composition of the alloy specified by the distribution of the chemical phases can only be evaluated by a relative grey scale value resulting from different attenuation coefficients. In general, this does not allow quantitative conclusions of the material under examination. As the attenuation coefficients are not

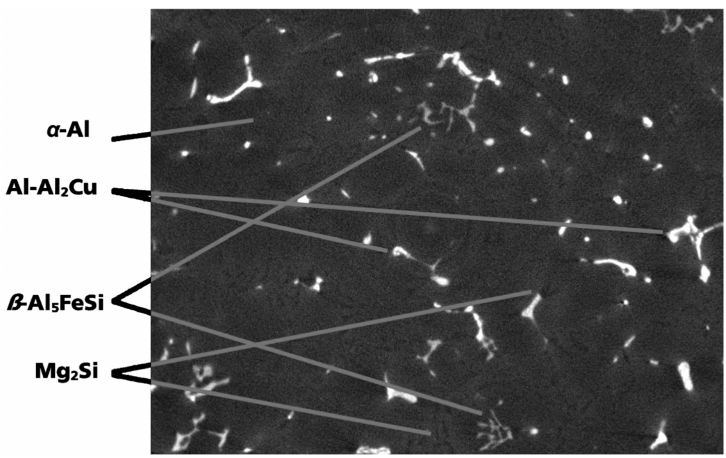

Fig. 1. Microstructural investigation using a standard 3DCT reconstruction of a $AlSi_6Cu_4$ alloy. The phase assignment is done reffering to an EDX-Analysis

only element specific, but also energy dependent, energy sensitive methods provide the possibility to obtain quantitative information. Compareable to common analysis techniques like the energy dispersive X-ray fluroscopy (EDX) the dual-energy method provides information about the elemental composition and the physical density of the specimen. This quantitative extension, the larger measureable volume size and the adequate achievable resolution suggest CT for application in metallography.

In this contribution we present our results in expanding the standard high-resolution CT to a quantitative metallographic microstructure investigation method. This is done in a two step approach, firstly by a linearization of the measured attenuation coefficients to correct beam hardening artifacts and secondly by application of the dual-energy method. Depending on the penetrated material length, the linearization method adapts the resulting grey value. This process leads to an equalization of the grey values representing the penetrated material and enables an accurate segmentation of the single phases all over the reconstructed volume.

The dual-energy approach is based on a method from medical CT imaging also known as rho-Z-projection (Heismann et al. 2003). This method employs two measurements of the object using different X-ray spectra and yields the effective atomic number and mass density of the specimen. The results considering the performance, imaging quality and reliability will be presented by the investigation of a typical alloy applied in fields with high demands on quality.