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Importance of Computer in Quantitative Analysis of Microstructure

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ABSTRACT

In this paper is shown the importance of computer assistance in quantitative analysis of microstructure, describing the quantitative metallography. The ilustration of computer role is given by showing some measure realized with help of Olympus analySIS auto software, "Calculation of Interlamellar Spacing".

The paper show not only the relationship between physic and computer systems but it is olso important the rezults of interlamellar spacing calculation for steel sampels with diferent contents of carbon.

INTRODUCTION

Since many physical and mechanical properties of materials are closely related to their microstructure, technologies to control the microstructure of materials have been well developed to obtain suitable properties. Image Analysis (I/A) systems represent a solution of many problems in physic and biology too. Special processing boards that fit in standard microcomputers are used to perform functions such as gray level transformations and numerous binary operations. These boards are composed of numerous modules, and software modules are used for control of the hardware modules. The software libraries use programming languages such as Basic or C. The manufacturers of image analysis systems create user interfaces so that relatively simple instructions can be used to interface with the software libraries and thus control the image processing functions. [1]

When doing a quality examination of a microstructure, the highly interpretation is based in the experience of the observer. So the estimation can be indicated from subjectivity. In quantitative analysis is intent to pull over this subjectivism by doing measures with standard procedures or unification procedures. The ingredients of microstructure measures in order to benefit believable and comparable data that to serve to the processes of metal tooling/producing and its quality control. Because of rigorism of materials technical specification and by narrowing their latitude attributes quantitative characterization of microstructure is required.

QUANTITATIVE METALLOGRAPHY

The quantitative analysis plays a very important role in modelling the mechanical properties as a function of particle parameters. It can provide relations between processes, microstructures and mechanical properties and supply the first hand data that is necessary and important to establish a reasonable mathematical model.

In summarized terms the definition of quantitative metallography can be given as;

"*Determination of microstructures specific characteristics by doing quantitative measures in on patterns or metallographic image*"

Or another definition is given as;

The quantitative methalography (or stereologya) is about the relationship quantitative between the measures done in two dimensional plan of sample polarization, and characteristic measures of microstructure elements in material three dimensional. [2]

Principle applications of Stereology make possible that, because of two dimensional measures (in metallographic sample), certain information can be derived in real three dimensional structure of material, which complete and raise the quality of microstructures analysis.

Typical microstructure measures include number, length, width, and surface on structure elements, and the relative quantity of a component or a phase. [3]

Common applications of quantitative metalography are related with;

- Grain size estimation
- Size estimation of screen/boundary surface between phases and/or grains
- Grains size estimation, characterization of their shape and their dispersal.
- Phase analysis (determination of fraction displacement of particular phases in a multiphase structure).
- Determination of grains orientation, and characterization of textures.

Also quantitative metalography is used widely for specific evaluation in surface casing, like surfeit diffusion, overlay thickening, oxidation or decarbonization thickening.

The manual quantitative metallography is sometimes difficult, tedious and time-consuming especially when the microstructure is complicated or of a fine scale. The automatic measurement of an image analyzer can give inaccurate data if the microstructure has a bad contrast or the analyzed features have a discontinuous outline. Recent fast development of computer techniques improve image processing remarkably. [4, 5]

Figure 1 Microscope and a pc needed for to make image analysis

In the meantime the software such as *PhotoLib3.03 and Analysis auto software* produced by Olympus Company have been developed for quantitative analysis of image. Using the Analysis auto software we time saving taking measurement automatically but what is more important the good data. It's important to calibrate first and to have the good image.

It should be noted that particle touching affects the measurement precision. The computer may consider touching particles as one particle. Although this can not affect the determination of area fraction the aspect ratio may be misunderstood. Increasing the magnification to separate the particles can alleviate the error. The present work I will illustrate these by presenting several some examples in steels specimens in deferent carbon content to obtain the first hand data.

CALCULATION OF INTERLAMELLAR SPACING

Since the first report on pearlite at the end of the 19th century by Sorby [6], extended research was made on this particular phase mixture and many of its secrets were uncovered. One of the earliest and most intriguing problems was the process of its formation. Although Sorby already suggested that the ferrite-cementite aggregate was a product of transformation of austenite at a certain temperature, this fact was not immediately accepted by the community of scientists.

Pearlite lamellae are not arranged chaotically but they are usually clustered in groups. A volume where the platelets tend to be homogeneously spatially and crystallographically oriented has been called in the past zone, grain, set of lamellae, unit of pearlite, pearlite unit and colony [7].

For calculating the interlamellar spacing we need good image showing clearly the lamella and the spacing between each other and the software, with help of which we can measure. I measured the interlamellar spacing in steel sample with 0.15%C (C-carbon), 0.45%C, 0.60%C and 1%C cooling with furnace, air, and ventilate.

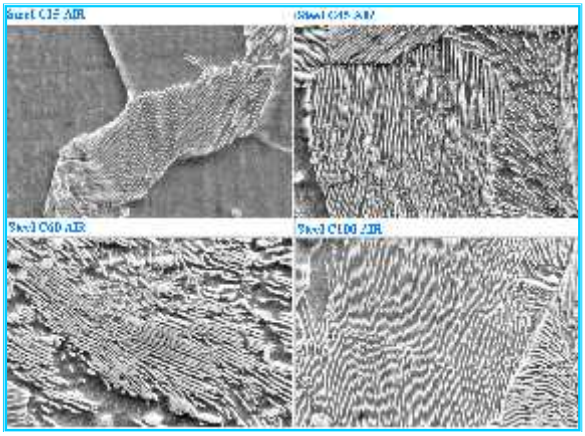

Figure 2 SEM micrography showing interlamellar spacing in different sample with different content of carbon.

The fields for SEM pictures were chosen so, that the lamella distance is minimal, that means, the lamellas are nearly perpendicular to the section plane.

For interlamellar measures is used one of three methods theoretically well known. For which sample we take 5 micrograph and in which micrograph we make 5 measures in 5 frames. We make this for the unique reason for to minimize error.

In Figure (3) are showing some measure of the interlamellar spacing in sample steel C15 which is cooling air.

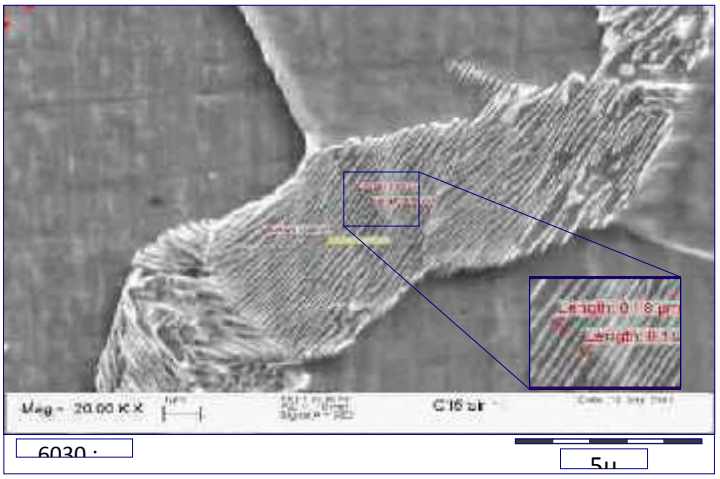

Figure 3 SEM micrography showing the measure of the interlamellar spacing in sample steel C15.

The results that we got for the samples cooling in air are shown in Table 1.

Table 1 Interlamellar Spacing for Different Samples Air Cooling.

Type of sample	Interlamellar spacing (μm)
Steel C15	0.19 μm
Steel C45	0.21 μm
Steel C60	0.22 μm
Steel C100	0.18 μm

From the results taken from the table shown before, for sample with different content of carbon cooling in air, is seen that interlamellar distances are nearly the same. From the results it can be seen that the interlamellar spacing doesn't change much within statistical error limits.

In follow are show measures of interlamellare spacing (ILS) for two sample steel with 1% carbon and steel with 0.6% carbon cooling in furnace air and ventilate.

Table 2 Interlamellar Spacing (ILS) for Different Samples with Different Cooling.

	Interlamellar spacing (μm)		
Type of sample	Furnace	Air	Ventilate
Steel C 100	0.53 μm	0.16 μm	0.20 μm
Steel C60	0.32 μm	0.21 μm	0.28 μm

From the Table 2 it's clearly shown that experimental data's of ILS for two sample steel C60 and steel C100 growth from air in ventilate and more in furnace, where sample cooling inside it. All data has been processed from software I mentioned before. ILS it's changed for different frame of micrography. This changed various from 0.05 μm to 0.01 μm. ILS change according to cooling method which has different boundary for different sample.

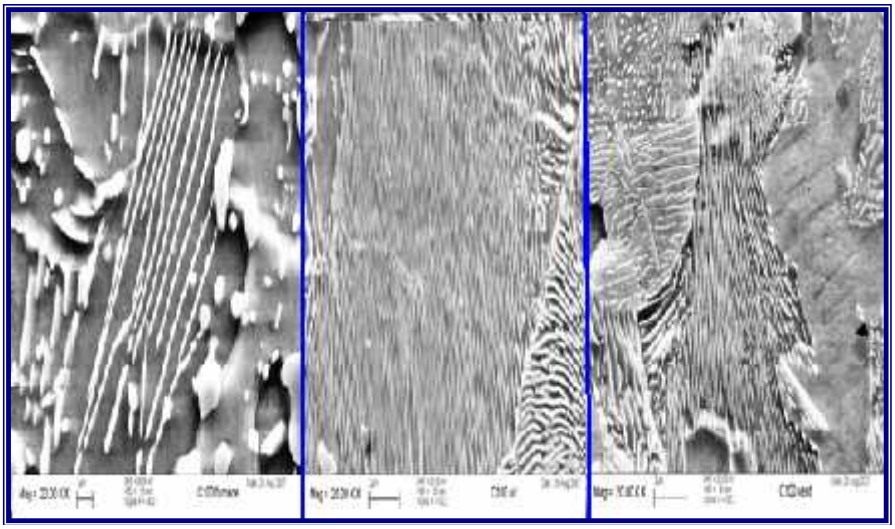

Figure 4 Steel micrography with 1% carbon with different cooling.

CONCLUSION

Relationship between physic and computer science, and production of softwares gives an answer a lot of unknown question, also help in taking more good datas. Another benefit using those softwares is to minimize error and the easiness and fast data given.
From results we see that for different type of sample with different %C we have nearly the same interlamellar spacing in cooling air. That's mean that for the sample cooling in air the interlamellar spacing doesn't depend from carbon contents. ILS for two sample steel C60 and steel C100 growth from air in ventilate and more in furnace, where sample cooling inside it. For more carbon contents than 0.60 % we saw that interlamellar spacing depend from heat treatment.

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