DOI: 10.1017/S1431927605506329
Microsc Microanal 11(Suppl 2), 2005

PRACTICAL USE OF SHAPE PARAMETERS FOR QUANTITATIVE SEGMENTATION OF MICROSTRUCTURAL AND SURFACE FEATURES

Luis Rogerio de Oliveira Hein *

* UNESP – São Paulo State University, Department of Materials and Technology, Materials Processing and Characterization Group, Materials Image Analysis Lab, Av. Ariberto Pereira da Cunha, 333, 12516-410, Guaratingueta, SP, Brazil, rhein@feg.unesp.br, (55) 12 31232852

Most of commercial digital image processing and analysis software are limited to offer conventional tools for feature characterization that are often based only on brightness data. Shape parameters may describe quantitatively the morphology of particles, grains or pores, but their use is almost limited to qualitative analysis. Features are classified as “rounded”, “concave”, “elongated”, etc., and this classification is enough for most cases. In this work, some applications of shape descriptors as complimentary tools for feature segmentation or quantitative analysis, developed by Materials Image Analysis Lab, are presented and discussed.

There are dozens of shape parameters in literature that consist generally on dimensionless relations of size parameters. In materials engineering, the most popular of them is the *aspect ratio*, that is the ratio between the major and minor axes that fit to the feature length and breadth. In ceramics, it express the elongation of grains and can be used to evaluate textured materials, but it can not provide any other relevant information, such as concavity or surface irregularities. So, a complete morphology characterization must be based on the association of two or more shape parameters.

In general, shape analysis may follow grey scale or color thresholding and all previous image enhancement operations. Many artifacts can be introduced by both sample preparation and image processing. For instance, in ceramography, grains can be broken by grinding or polishing and shades can appear in light micrographs. After thresholding, these broken grains can be displayed as concave ones. The correct adjustment of a single shape parameter, known as *perimeter ratio* or *convexity*, must eliminate most of these fractured grains from quantitative analysis [1]. Combined to aspect ratio, perimeter ratio can differentiate precipitates in aluminum alloys [2]. Combining ranges of aspect ratio, perimeter ratio and rectangularity, one can find and classify almost all classes of inclusions in steels, avoiding to measure artifacts as polishing scratches and comets [3].

Some careful procedures must be adopted for range definition in segmentation by shape parameters. To describe the behavior of pits morphology in locallized corrosion of metallic alloys, observed in the plane of depth, a group of shape descriptors have been tested using pictures formed by families of semi-circles, circles, triangles and rectangles [4]. It permitted to define a chart with the ranges for classification of hemispherical, spherical, conical or cylindrical pits, described by rectangularity parameter. Selection of parameters must respect the concepts related to microstructure or surface formation, which provides the foundations for test pictures creation.

A prior testing to establish range limits is often needed. It requires a preliminar sampling from a representative subset of digital images, testing the influence of artifacts introduced by sample preparation or image processing. In a study to evaluate the characterization of ceramics grain size from fractured surfaces, the range for perimeter ratio were tested to separate transgranular and intergranular facets, avoiding to consider ghost boundaries and breakouts [5]. In this case, the errors introduced by watershed filtering were so significant that a skeletonization operation was used instead. These errors could be better evaluated due to experimental testing of shape descriptor range, interpreting microstructure features based only on fracture behaviour of ceramics. In another case study, a parameter for the description of textured ceramics is being developed from the behaviour of aspect ratio values, since equiaxial grains can not be considered for orientation measurement [6].

In conclusion, this text presents a series of examples developed in the Materials Image Analysis Lab to sketch a common procedure for the use of shape descriptors in quantitative image analysis.

REFERENCES

[1] E. Campos et al., *Mat. Sci. Forum 416-418* (2003) 725.
[2] R.Z. Nakazato et al., *Prakt. Metal. 38* (2001) 74.
[3] P.R. Oliveira, L.R.O. Hein, *Quantitative morphology description of inclusion in steels,* in preparation
[4] E. N. Codaro et al., *Mat. Sci. Eng. A 334* (2002) 298.
[5] A.L. Horovistiz et al., *J. of Eur. Cer. Soc. 24* (2004) 619.
[6] A.L. Horovistiz, L.R.O. Hein, *Quantitative description of textured ceramics*, in preparation
[7] This research was supported by CNPq and FAPESP.