ALPHA GRAIN CHARACTERIZATION IN TITANIUM

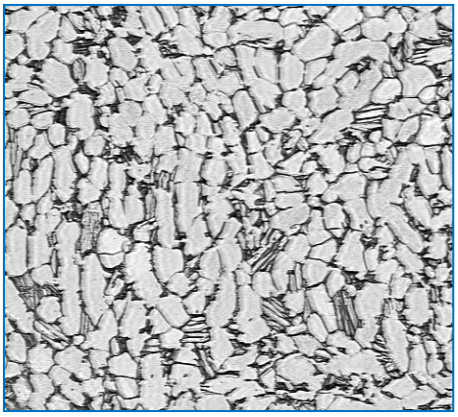

Figure 1: *Original image.*

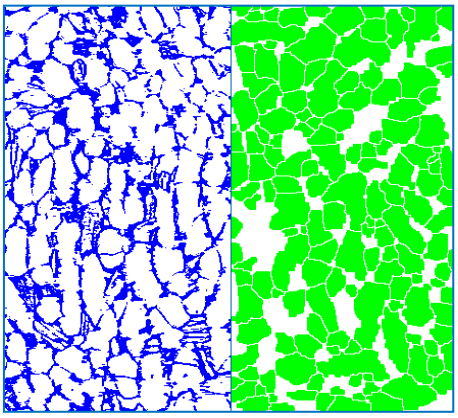

Figure 2a: *Blue binarization by Gray Thresholding of the grain boundaries.*

Figure 2b: *Alpha grains isolated from the matrix.*

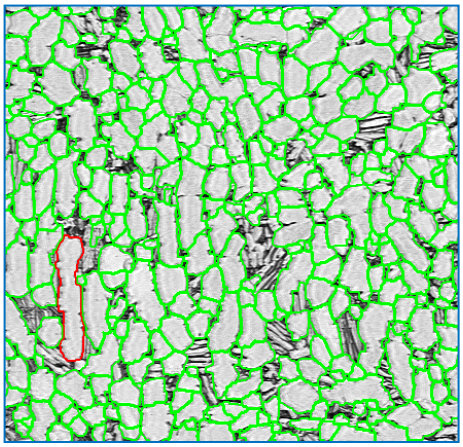

Figure 3: *Alpha grain boundaries overlaid against the original image. The red outline object was the longest alpha grain the system found through the analyzed fields.*

Sample Description

Two samples of titanium (Ti-6Al-4V) electro-polished and etched are submitted.

Purpose of Analysis

Demonstrate the ability of **Clemex Vision image analysis system** to discriminate and measure alpha grains, transformed beta phase (acicular alpha grains) and colonies (grouped acicular alpha grains).

Procedure

Certain gray filters are used to improve the contrast of original image. The grain boundaries are binarized into blue. Alpha grains and colonies are discriminated from the matrix after executing several selected binary instructions. Transformed beta phase is classified as a colony if containing at least 2 acicular alpha grains. That criteria are set arbitrary and they could be set differently.

Equipment

Image Analysis System:	Clemex Vision/Grain size module
Microscope:	Nikon Epiphot 200
Camera:	Sony SC-77CE B&W
Magnification:	200X
Stage:	Marzhauser EK8B-S1

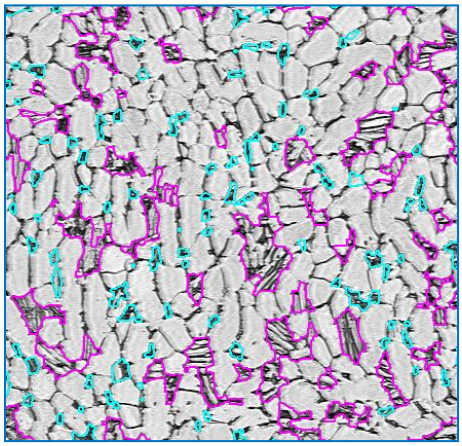

Figure 4: *Area percentage of transformed beta phase (acicular alpha) and primary alpha phase compared to field.*

Results

Field Measurements are performed to obtain area percentage of each phase and alpha grain size. Grains that were sectioned by the field are eliminated prior to *Object Measurements*. *Length*, *ASTM E112* grain size, *Aspect Ratio* and *Orientation* measurements are then performed on each object. Final results can be printed directly from Clemex Vision. Raw data are linked to their respective objects for validation purpose. Raw data can also be exported in Excel format.

Transversal Sample:

Field Measurement	*Alpha Grain Size ASTM E 112*	*Alpha Area (% on field)*	*Transf. Beta Area (% on field)*	*Colonies Area (% on field)*
Minimum	9.65	69.09	25.26	14.98
Maximum	9.97	74.74	30.91	21.51
Mean	9.79	72.90	27.10	17.80
Standard Deviation	---	1.24	1.24	1.68

Object Measurement	*Alpha Grain Size ASTM E 112*	*Alpha Grain Length (µm)*	*Alpha Grain Aspect Ratio*
Minimum	6.51	3.7	1.07
Maximum	13.42	85.6	3.89
Mean	9.95	15.8	1.52
Standard Deviation	---	7.2	0.30

Longitudinal Sample:

Field Measurement	*Alpha Grain Size ASTM E 112*	*Alpha Area (% on field)*	*Transf. Beta Area (% on field)*	*Colonies Area (% on matrix)*
Minimum	9.36	70.28	23.62	14.18
Maximum	9.78	76.38	29.72	22.47
Mean	9.58	72.71	27.29	19.09
Standard Deviation	---	1.29	1.29	1.71

Object Measurement	*Alpha Grain Size ASTM E 112*	*Alpha Grain Length (µm)*	*Alpha Grain Aspect Ratio*
Minimum	6.33	4.0	1.06
Maximum	13.25	96.2	4.14
Mean	9.87	16.3	1.53
Standard Deviation	---	8.6	0.30