

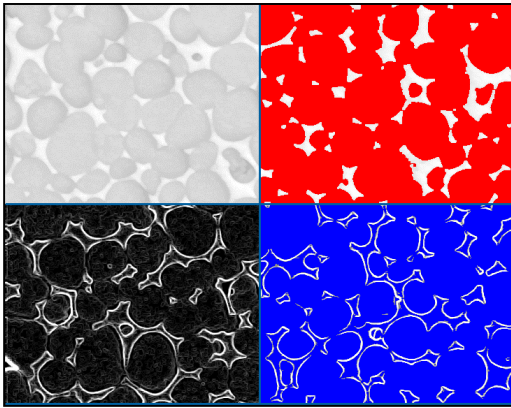
## Dihedral Angle of Tungsten Heavy Alloys Image Analysis Report 233

### Sample Description

Two samples of tungsten heavy alloys as sintered.

### Purpose of Analysis

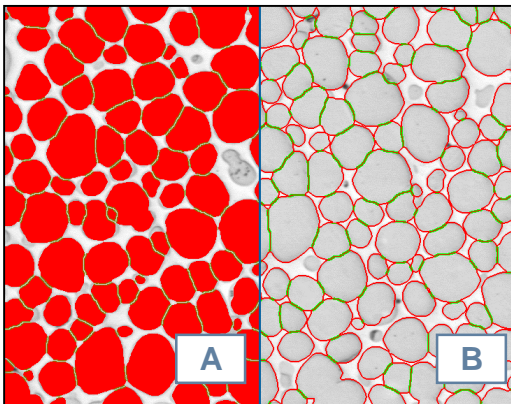
Demonstrate the ability of the Clemex Vision image analyzer to discriminate all spheres and measure their dihedral angle.



**Figure 1:** *Top left:* Original image (200x, 0.64  $\mu\text{m}/\text{pixel}$ ). *Top right:* Binarization (red) by Gray Thresholding of the Tungsten spheres. *Bottom left:* The original image was modified by a gray transformation to outline the spheres (Kirsch). *Bottom right:* The modified image was binarized into the blue bitplane.

### Procedure

The original image (red bitplane) and the modified image (blue bitplane) were combined and processed to obtain the final results (Figure 2). Some binary operations were necessary to complete and separate spheres (Opening, Separate, Zone, Chord Size).



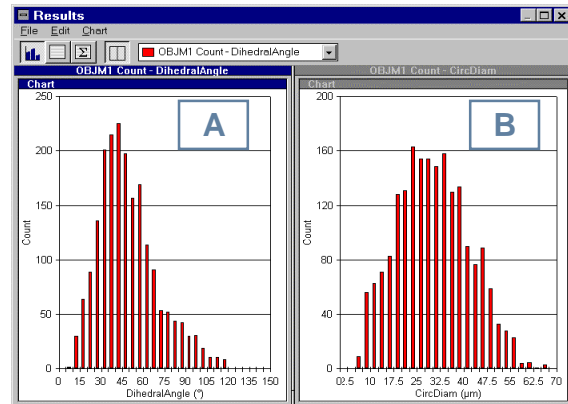
**Figure 2:** *a)* Final detection of spheres (red) and touching perimeter (green) overlaid against the original image. *b)* Same as a), in outline view.

### Procedure (continued)

Dihedral Angle measurement is a custom measure. It uses the mean touching perimeter of each particle instead of individual touching perimeter. The linear focusing mode was used to obtain more realistic results.

### Results Summary

	#2		#3	
Meas.:	Dihedral Ang.	Diameter ( $\mu\text{m}$ )	Dihedral Ang.	Diameter ( $\mu\text{m}$ )
Min.:	10.01 <sup>0</sup>	6.8	8.85 <sup>0</sup>	6.8
Max.:	119.21 <sup>0</sup>	53.9	118.97 <sup>0</sup>	67.3
Mean:	51.09 <sup>0</sup>	21.9	49.45 <sup>0</sup>	30.2
Std Dev:	19.83 <sup>0</sup>	8.0	20.99 <sup>0</sup>	11.6
Count:	3454		1995	



**Figure 3:** *a)* Dihedral angle distribution. *b)* Circular diameter distribution.

### Equipment

#### Image Analysis

**System:** Clemex Vision PE  
**Camera:** Sony XC 77CE  
**Microscope:** Nikon Epiphot-200, 20x  
**Stage:** Motorized Marzhauser