Average Grain Intercept (AGI) Method

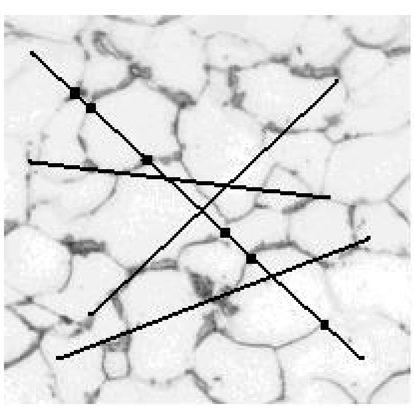
The average grain intercept (AGI) method is a technique used to quantify the grain - or crystal - size for a given material by drawing a set of randomly positioned line segments on the micrograph, counting the number of times each line segment intersects a grain boundary, and finding the ratio of intercepts to line length. Thus, the AGI is calculated as:

AGI = (number of intercepts)/(line length).

A sample with small crystals will have a high AGI value compared to a sample with large crystals.

Figure 1 shows a micrograph (microscopic photograph) of a metal sample that has been polished to produce a smooth flat surface and then etched to highlight the boundaries between crystals (or grains). The material within each boundary is a single, or individual, crystal that has been intersected (i.e., sliced through) by the polishing plane. On this micrograph the micron marker indicates the magnified size of the features. A micron marker is more useful than giving the magnification (number of times □X□) since the micron marker is always scaled properly even when subsequent enlargements or reductions are made of the micrograph.

The line segments that are randomly superimposed on the micrograph of Figure 1 show the first step in determining the AGI (average grain intercept). The small squares on one of the line segments indicate (approximately) where the line segment intersects the grain (crystal) boundaries. To calculate the AGI, the intersections for the other randomly placed line segments would also need to be obtained. The count of boundaries and the total length of the line segments would then be used to calculate the AGI for the sample.



needs micron marker

Figure 1. Micrograph of Crystals with Random Line Segments

The picture shown in Figure 1 is a digitized, gray scale image of the view seen in an optical microscope. The reason that the grain boundaries are darker than the grains themselves is that the acid used to etch the surface preferentially removes material at the grain boundaries. This results in a sample with channels or □mini-canyons□ running along the grain boundaries. Along these boundaries, the light used to illuminate the sample is not reflected back into the microscope eyepiece. This produces the observed variation in gray scales shown in Figure 1. A digitization of Figure 1 can be stored in as a data file which contains an array of numbers where each number refers to the gray scale value for each pixel of the micrograph. A sub-sample of the complete Figure 1 file is shown in Table 1; this sub-sample shows the gray scale values for the square superimposed on Figure 2 and exploded in by itself in Figure 3. Gray scale values range from 255 for black to 0 for white.

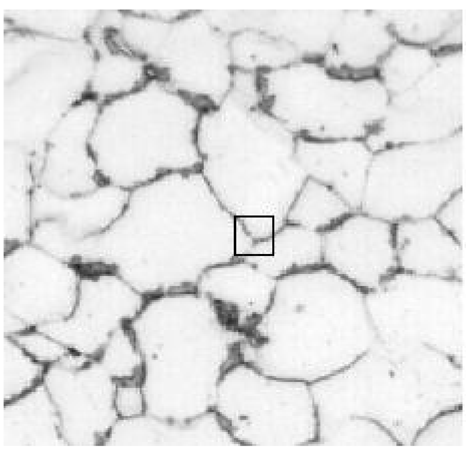


Figure 2. Micrograph of crystals with sub-sample shown.

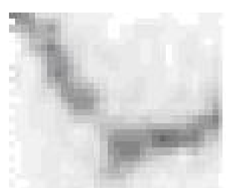


Figure 3. Sub-sample of micrograph
shown in Figure 2.

Table 1. Digital file for sub-sample from micrograph of crystals shown in Figure 3.

131	95	38	37	33	15	12	19	13	8	10	12	12	14	3	7	16	18

79	100	81	86	31	20	17	16	7	10	18	19	16	15	11	13	12	15
16	66	70	81	36	27	22	16	7	12	18	15	16	10	16	18	7	13
8	54	81	118	61	37	23	24	20	19	16	9	18	5	19	22	10	18
19	16	40	98	95	48	20	25	28	24	19	15	22	6	22	22	18	25
31	11	38	102	107	57	23	20	20	20	22	23	20	8	20	15	22	26
23	13	34	70	97	77	55	35	18	21	26	22	16	15	25	13	32	37
11	17	29	31	90	103	99	64	30	32	34	21	19	28	37	22	50	57
15	19	19	24	43	93	87	58	21	36	25	25	27	30	31	33	47	78
15	17	18	22	30	44	45	56	55	53	45	59	48	51	57	83	99	110
13	15	15	20	26	15	20	49	91	92	90	98	120	120	106	113	84	64
11	13	14	19	26	23	27	37	101	122	122	100	136	128	99	99	58	39
10	13	14	20	18	27	35	35	92	112	102	67	54	41	17	37	27	22
10	14	15	20	13	19	30	47	81	78	56	38	30	27	20	34	27	18
13	15	16	21	17	22	23	48	59	52	27	28	11	16	22	19	14	8
15	17	16	20	23	32	18	32	30	39	19	25	24	17	20	12	25	22