**Elementary Stereology for Quantitative Microscopy**
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**Lecture – 17**
**Counting of Grains and Particles – Part 4**

The Jeffries grain sizes coming out; so, what I will now do is, I was just interested in calculating another derived quantity called number density. So, the number density, if you recall the lecture, we can try to do that exercise for that graphite nodular microstructure which is quite interesting; because the nodular shape is almost close to the spherical or sphere.

And if you recall for the sphere, the expression what professor Sandeep has demonstrated or derived is N V is equal to 1 by beta times N A to the power 3 by 2 by P P to the power half, square root of P P or whatever; So, where the beta has a number, it is 6 pi, 6 divided by pi to the power half. So, we can just try that exercise, just for a curiosity, I would like to try.

So, there again because you can use that same probe as the earlier one and you can count those area. Since, we have already done the exercise on N A to calculate this space filling grains and it is of a similar nature, so what I will do it, I just do a demonstration or again I do not want to, we can do a demonstration.  It is not a problem. So, I will just take up the microstructure again and then do this calculation.

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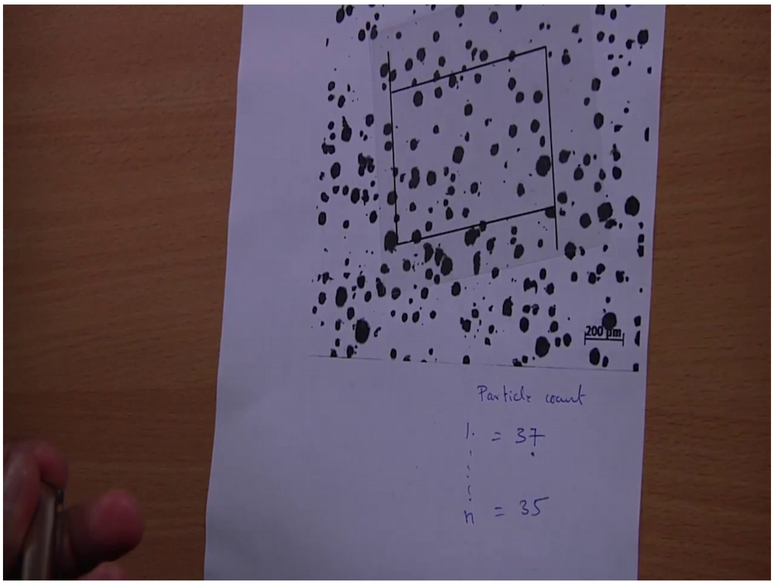


You can keep this graphite nodule, nodular microstructure like this and then the probe can be kept like this and you can just keep this and then start counting. So, the rule is, you have to exclude this particles which is intersecting these lines and include the particles which is intersected by this line.

So, just I count for the. So, you can just start counting like this 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37. So, it is 37. So, one can do up to n and in this case, I think I have done up to 35, n up to 35. So, you can count this and then put it in the excel sheet as you like.

So, again since we know this dimensions already, we do not have to, it is easy for us to calculate this again.

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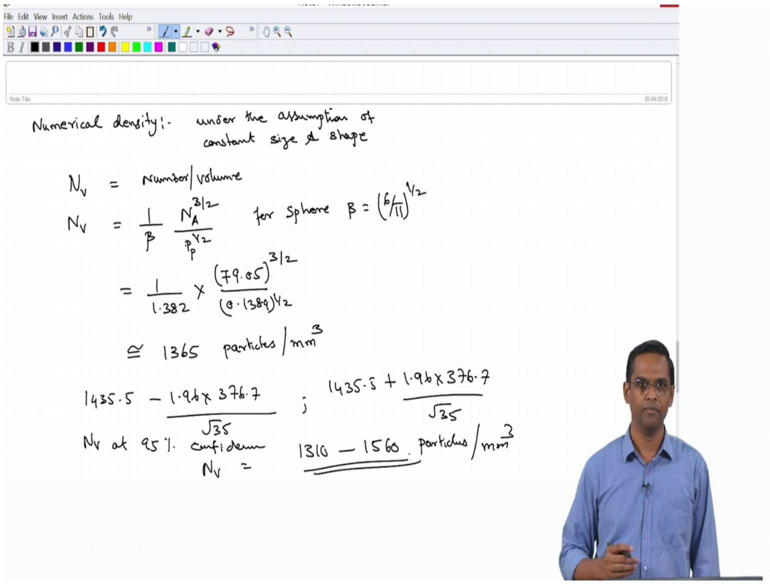


So, let us now start writing this Numerical density under the assumption, assumption of constant size and shape. So, we write this expression N V which is equal to number per volume and N V is written as 1 by beta times N A to the power 3 by 2 by P P to the power half.

For spheres, beta s 6 upon pi to the power half. So, which is you can just do this calculation 1 by 1.382 into 79.05 divided by 0.1389 to the power half, this is what 3 by 2. So, you will get approximately about 1365 grains or particles; particles per mm cube.

See here, I have used, if you choose to follow the micrometer scale here, this number will be too small because it will be a micrometer cube. So, the number of particles, if you can imagine in the micrometer cube volume, will be too less.

So, in order to have that you know feel, so I converted that micrometer into mm. So, now, you have mm cube, you have a larger volume and then you get some reasonable number something like this. So, you know that P P and N A already. So, for this we have calculated.

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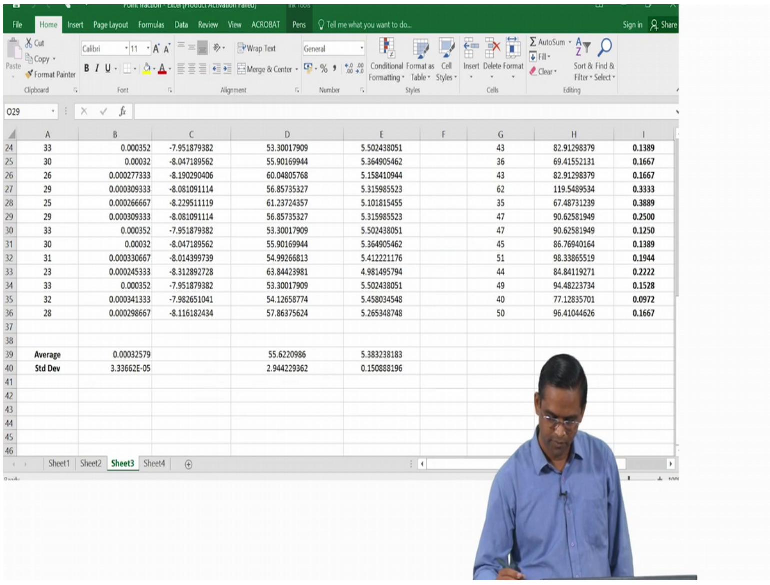

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 24 | 33 | 0.000352 | -7.951879382 | 53.30017909 | 5.502438051 | | 43 | 82.91298379 | 0.1389 |
| 25 | 30 | 0.00032 | -8.047189562 | 55.90169944 | 5.364905462 | | 36 | 69.41552131 | 0.1667 |
| 26 | 26 | 0.000277333 | -8.190290406 | 60.04805768 | 5.158410944 | | 43 | 82.91298379 | 0.1667 |
| 27 | 29 | 0.000309333 | -8.081091114 | 56.85735327 | 5.315985523 | | 62 | 119.5489534 | 0.3333 |
| 28 | 25 | 0.000266667 | -8.229511119 | 61.23724357 | 5.101815455 | | 35 | 67.48731239 | 0.3889 |
| 29 | 29 | 0.000309333 | -8.081091114 | 56.85735327 | 5.315985523 | | 47 | 90.62581949 | 0.2500 |
| 30 | 33 | 0.000352 | -7.951879382 | 53.30017909 | 5.502438051 | | 47 | 90.62581949 | 0.1250 |
| 31 | 30 | 0.00032 | -8.047189562 | 55.90169944 | 5.364905462 | | 45 | 86.76940164 | 0.1389 |
| 32 | 31 | 0.000330667 | -8.014399739 | 54.99266813 | 5.412221176 | | 51 | 98.33865519 | 0.1944 |
| 33 | 23 | 0.000245333 | -8.312892728 | 63.84423981 | 4.981495794 | | 44 | 84.84119271 | 0.2222 |
| 34 | 33 | 0.000352 | -7.951879382 | 53.30017909 | 5.502438051 | | 49 | 94.48223734 | 0.1528 |
| 35 | 32 | 0.000341333 | -7.982651041 | 54.12658774 | 5.458034548 | | 40 | 77.12835701 | 0.0972 |
| 36 | 28 | 0.000298667 | -8.116182434 | 57.86375624 | 5.265348748 | | 50 | 96.41044626 | 0.1667 |
| 37 | | | | | | | | | |
| 38 | | | | | | | | | |
| 39 | Average | 0.00032579 | | 55.6220986 | 5.383238183 | | | | |
| 40 | Std Dev | 3.33662E-05 | | 2.944229362 | 0.150888196 | | | | |

So, I have taken that and then just put them into the excel sheet. So, if you can see that, this is what I have done in this column. You can see that the particle counts N A, then finally, N V. So, I get around average number of particles about 1435 and the standard deviation is about 376.

So, you can just report it like this, 1435.5 minus 1.96 into 376.7 divided by 35, 1435.5 plus 1.96 into 376.7 square root of 35. So, which is, so N V at 95 percent confidence, confidence is you can write N, N V is equal to 1310 to 1560 particles per millimeter cube.

So, this is how you can just visualize. Just to give you an exercise you know which you have the parameters N A and P P. So, it is a good exercise to try and all that you have to be careful is about the converting the scale and then look at the micro marker. Normally, people commit mistakes in this, even it has several times if you try, some small error here and there, it will, you will miss because of the not considering the right scale and so on.

But nevertheless if you taken care of this. And this kind of exercise is very good to understand the derivation of the 3 D quantities by the stereological parameters. So, I hope this exercise was useful and then you can try similar exercise on some of the new microstructures again. So, with this I close this tutorial.

Thank you.