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**NATIONAL PROGRAMME ON TECHNOLOGY ENHANCED LEARNING**

# Tutorial- 5
# Materials Characterization

## Quantitative metallography

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Hello everyone welcome back to this material characterization course our nation by NPTEL and we have been looking at the tutorial class for solving some of the optical microscopy and calculating some of the micro structural parameters were such as grain size volume fraction etcetera. In the last class I just demonstrated some of the standard statistical methods how to represent the micro structural data for example wall infection and so on.

I will continue the same exercise in calculating the volume fraction using the micrographs in the last class what we have done we have just demonstrated how to use a reticule in IPS or a micro microscope itself and look at the various fields and then take the data our random sampling from the microscope itself but using a micrograph how to do the same analysis that I will just show you.

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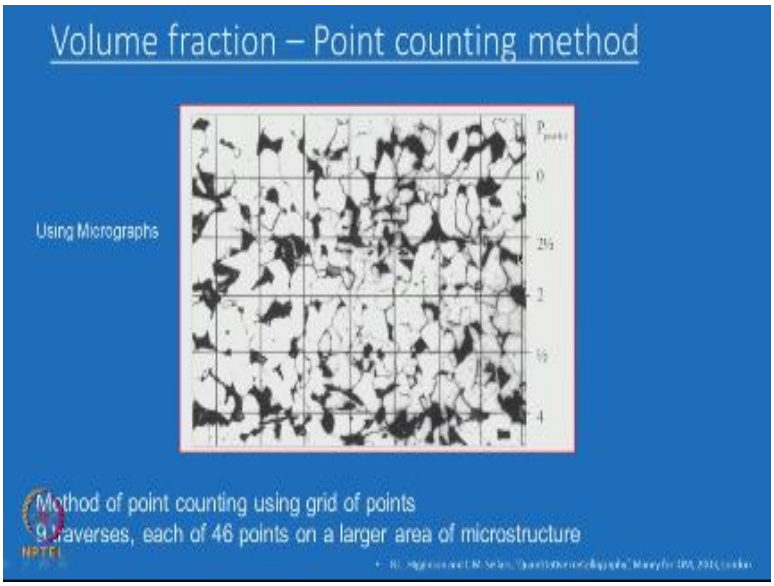


Look at the slides what I have shown here this is the same microstructure instead of reticule we are now putting a grid points off for a choice for example if you see that here also the method is called point counting but then depending upon the size of the micrographs then you can use the Traverse line. In this particular case study 9 private line were used like this what I have shown here.

So the general rule is the distance between the Traverse line should be good enough and the golden rule is no to grid points fall on the same region of the interest for example here in a black face no two adjacent points from all the sides should fall in this point or this region so that is the Golden Road.

So if you look at this point you can see that none of this intersection the grid points falling on the second page that is why it is 0 and here you see that you can see that point number 1 point number 2 and this is taken as half so it is to hand off so similarly it is one and then two be stall the grid points are not falling on the second place.

So here if you see this is only taken as half just all the grid points are not falling on the second base so this is half so like that you the data which I am going to present on the blackboard is a nine traverses on each of 46 points on a larger area of microstructure but it is just only a sample is shown here how the counting is done and so on so i will just put the data on the blackboard.

Remember we are now interested in instead of using the reticule on a microbe microscope and we are using a micrograph to calculate be the same parameter volume fraction you just see whether we are getting this similar values.

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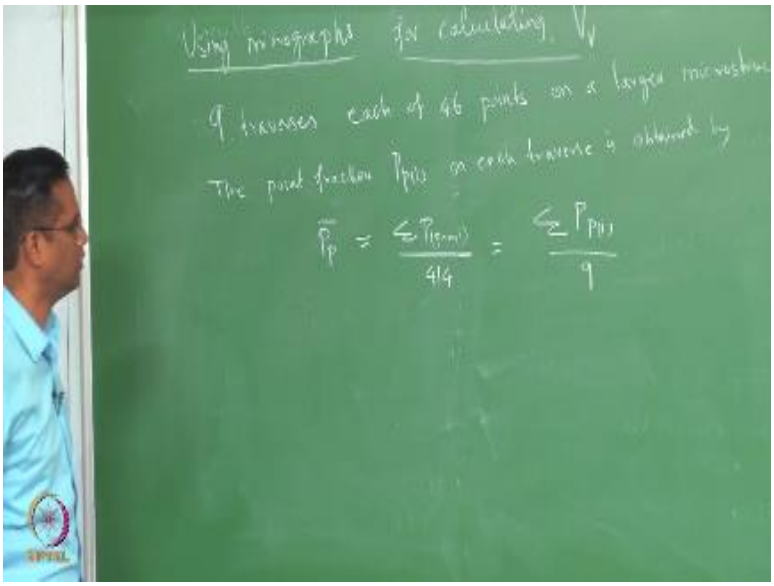


So i write the results here you so as I mentioned nine powers line were used on a micrograph each of 46 points on a larger area so similar we have seen this the point fraction can be calculated aided by the number of permit area /D be total that is time times the 46 points that is σ n which is also equivalent to the point faction / d9 traverse lines. So that will give you that creepy like we have seen in the previous example now we will just put the tabulation.

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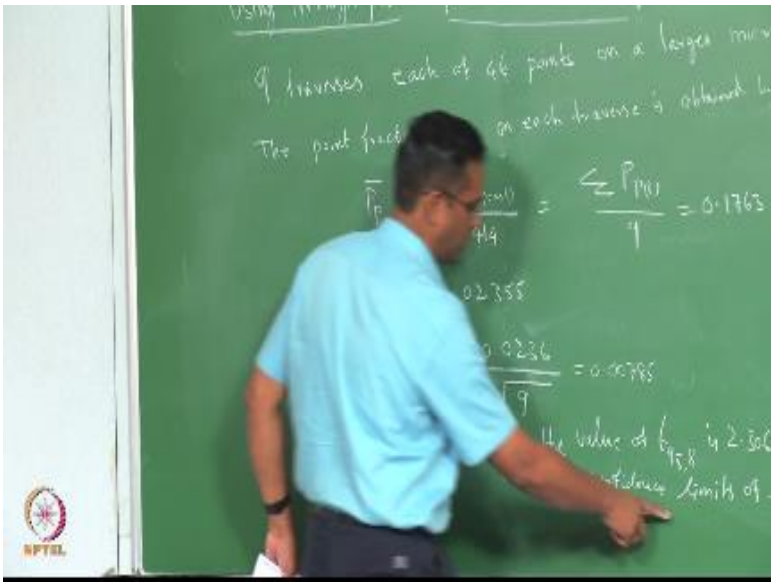

The mind traverses were used to obtain this data so this is the Traverse number column one column to number of points in the polite pp/ light column 3 is a fine fraction that is PP I so column 2is the raw data that is we actually count from the micrograph column 3obtained / column 2.5 x 46 so you get this σP and then σPP I so you substitute that here.

So what you will get is around so you can calculate the standard deviation which is 0.02355 and then standard error of P with nothing 0.0236/09= 0.07so what I have written here is we have simply substituted those values into this formula and then we get the pp/= 1763 standard deviation is this standard error is this and for mine measurements that means n- 1 is a degrees of freedom $8^0$of freedom the value of T 958that is T95 n - 1 is 2.3 06.

From the table what we have just did in the last class you can find out this leading to a 95% conference limits of + or - 0.0181 so now we can present the data in this fashion what i will do.

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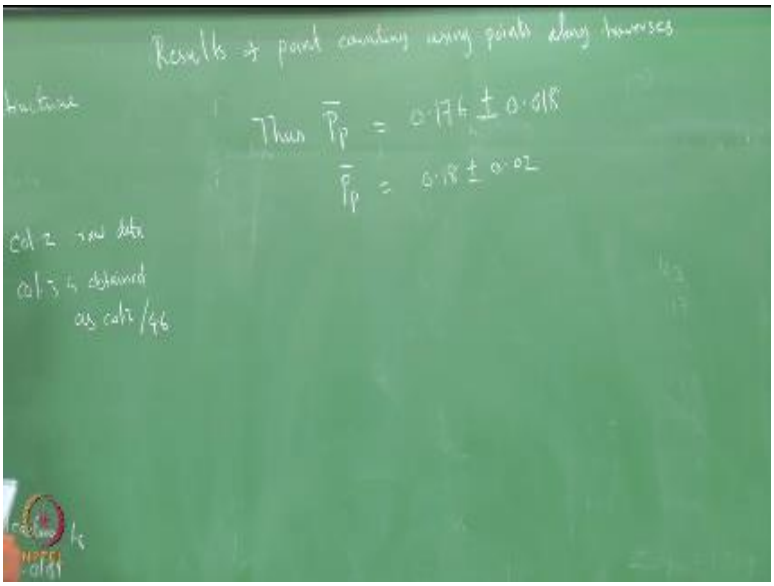


So what we are getting from this using the Traverse line and we are getting the value of 0.18 +- 0.02 which is very close agreement with what we have calculated the using be the example what we have seen in the case study of using reticule and a microscope the value of yours to be very close to this value.

So the same thing can be demonstrated using the linear analysis of similar microstructures what you can just have a look at the VA other slide what I am shown here you can also look at the point fraction.

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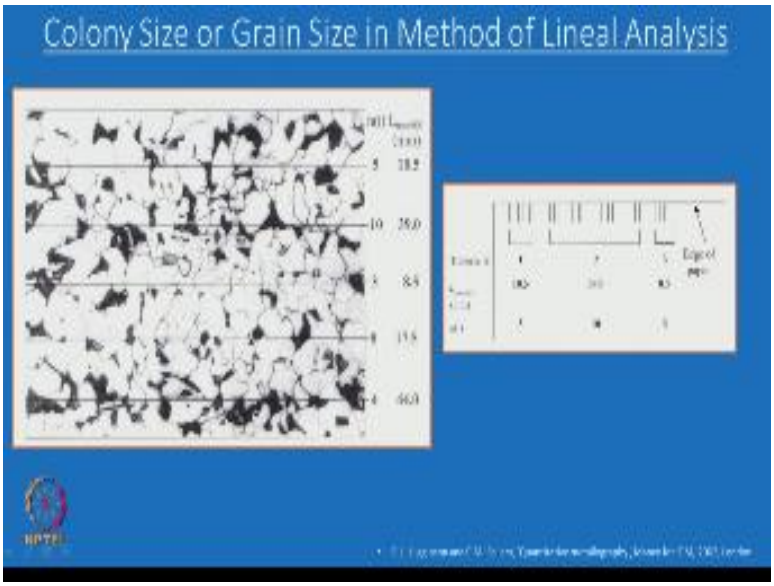


You can use the lineal analysis to calculate the colony size or a great size of the correct phase or the colony size that we be paralyzed face and you can have the micrographs like this and then take the Traverse line like this and here please understand we are interested in measuring lee the linear intercept that is L.

Ok so what I am going to demonstrate here is look at this Travis line it could be n number of towers line using that this the golden rule or statistical rule make sure this d Traverse lights are far apart and no 2intersection will fall on the same thing something like that. So what I am shown here is this is the D this is where the intercepts are calculated like that I will just show you how this is obtained.

So for example if I start counting from this line for exam this area what you are seeing here if I can just draw a get line like this vertical line that is what is shown here for example this one edge and then if I the other intersection if I draw other vertical line it is shown here the next line so now I will make sure that i am using a transparent sheet on this and then making this vertical mark on this micrograph assume that and the moment I make this two vertical line on these two intersections first one here and second one here.

Then I will move the tracing sheet to this now the second line what I have drawn here is become the first line for this intersection then I will draw another vertical line because this is another intersection so like that I will keep on moving this transparent sheet and get one a full set of a transverse then I call it as one so like that I will keep on doing this form number of measurements and then for each Traverse I will simply measure the length in terms of millimeter or centimeter and so on any unit and then number of intercepts involved for example here for example 1 2 3 4 and 5.

So 5 that is NI is involved here it is10 here it is 312 and then 3123 so the b2 are very close so don't get confused so like that you calculate the intercept and then try to measure this linear analysis using the intercept method so now i will just tablet the values on the blackboard for the reference.

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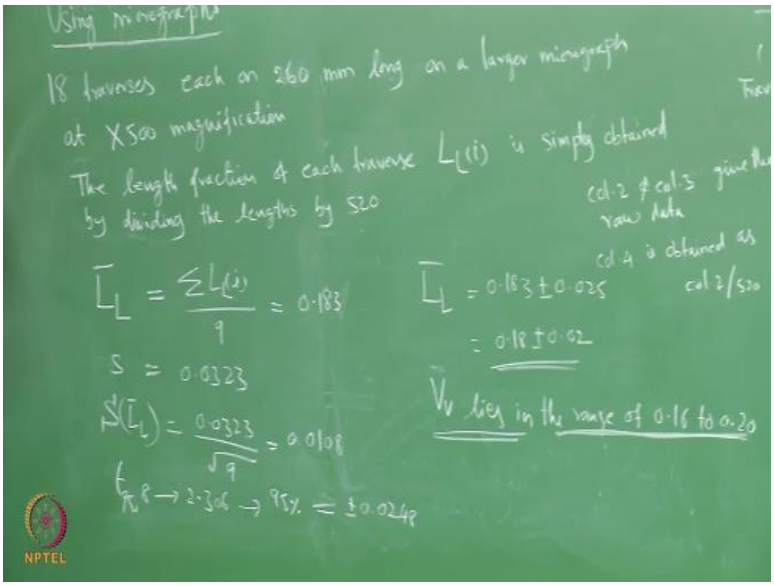


So what I am going to just tabulate the data fee I just read written here the 18traverses each one to 60 mm long on a larger micrographs obtain that the 500 x magnification see this magnification you have to decide whether the microstructure which you are looking at is a representative

enough to calculate these values you can always do it at 200x arachnid which may be very meaningful.

But if you're microstructure is too fine then you may have to choose to appropriate magnification and then as I said you have to you cannot rely on just calculation on each I mean only single micrograph see how to maximize the number of micrographs to obtain a meaningful result so you can also say that you know instead of 18 traverses to60 mm long you can say nine traverses about PI 20 mm long.

So for a convenience you can tabulate it into any form because the number of intercepts you are going to count the same so that is why I have said that the length fraction of this particular case L else is simply obtained by dividing the length whatever you say we are going to table it by 520 so you can use 18 to 60 or 90 520 both the both of them are going to give you the same result. so let me just you if you look at the complete data using the nine traverse line and the length of the par alight mm was calculated like I just showed you on the slide.

Looking at each intercept value and this is the number of such call weeks and that is n IE and then the lens fraction is LLI so the column two and three are raw data column for is obtained as column 2 / 5 20 like I just written here so if you can just substitute these values we are interested in obtaining LLI eat that is average length fraction is summation of so what we have got their point 11.1648 this submission 1 /9 is this.

And then we can calculate the S which is nothing but 0.023 and then standard error so this is small s and this is a capitals just to differentiate the error and the standard deviation so the degrees of freedom you see 8 so same thing you use the same value t.t 958 is 2.2 .3 06 lead to the confidence limit of so you say that 90, 58 it gives the ninety-95% confidence level limit which gives 2+ 1 -0.02 48 now we can present the result LLS/ 0.18 3 +.025 which may be rounded off to $0.18^{-\ 0.02}$ so which is again the BB what we have obtained in the previous calculation lies in the range of so this is the conclusion whether you use a point count or whether you use linear analysis you get the similar result for updating v.v.

So what I have just demonstrated through this case study is that you may use computer for calculating many of them are so you may be using how the software readily available in your laboratory it will just a click in the most button you will get all these values but you should know how these things are what that software does maybe involving some kind of a statistical analysis like this which you should actually try to see which was some readily available micrographs with you then you will appreciate the results much more better rather than simply taking this from the software.

So a similar analysis can be done on grain size and collie size which I have not shown here though I just started doing out on the slide but in another class I will just demonstrate some of these grain size calculation but for this the case studies what we have just looked at this by using microscope itself using at reticule or you can use the micrograph itself to calculate the volume fraction using this simple calculation but the point which I am trying to make is the analysis or very elementary but the data presentation is very important that is why we introduced some of these statistical methods which you should know and then how to present the result we you should not just give one value you should have the error bar and you should have standard deviation and conference level.

And so on that is why I introduced some of the statistical methods and also you should make sure that these sampling is random and then you should maximize see number of measurements then your values will be close to the reality are the representative of the microstructure which you are interested it so I hope these exercise in the tutorials shown are useful to you I will give you some of the assignments for you to practice or you can just I will just upload some of the microstructure like this are from of the particle distribution you try to do similar kind of an exercise and then get back to me whether it is if you have any difficulty. Thank you.

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