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Lecture-10
Materials Characterization
Fundamentals of Optical microscopy

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Hello everyone! Welcome back to this material characterization course. In the last class we just looked at some of the problems involving the basic principles of optical microscopy. In today's class also we will continue that tutorial class and I would like to solve two more problems and then we will move on to the next topic. So the problem number 6 which I am going to sorry problem number 5.

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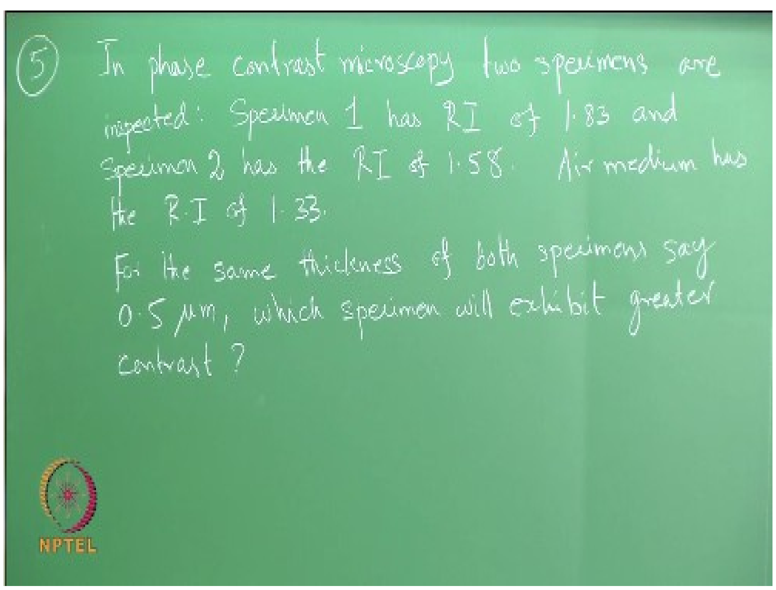

So this problem is involving the phase contrast microscopy principle; in a phase contrast microscopy two specimens are inspected specimen one has the refractive index of 1.83 and the specimen two has the refractive index of 1.58 and the air medium has the refractive index of 1.33 and if you assume that for the same thickness of the both specimens say 0.5 micron which specimen will exhibit greater contrast? So what is that I hope you will remember the formula which one should be used.

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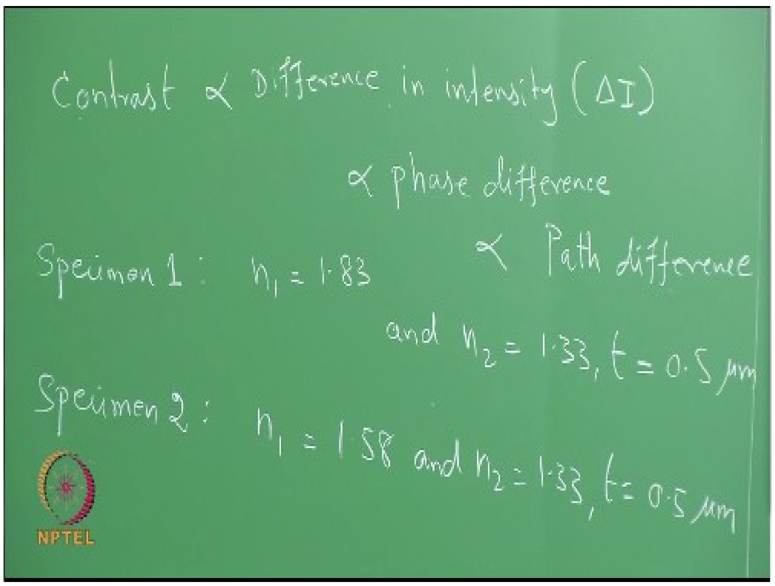

So let us start with contrast as we have discussed in the one of the class that contrast is a difference in the intensity that is you can write contrast is proportional to difference in intensity that is ΔI; which is proportional to phase difference and the phase difference is proportional to path difference. So this is how you have to connect all this phenomenon; contrast is proportional to difference in the intensity which is related to phase difference and which is again related to path difference.

So we can write for a specimen 1 and then specimen 2 we can write, so we can write like this for specimen 1 as well as specimen 2.

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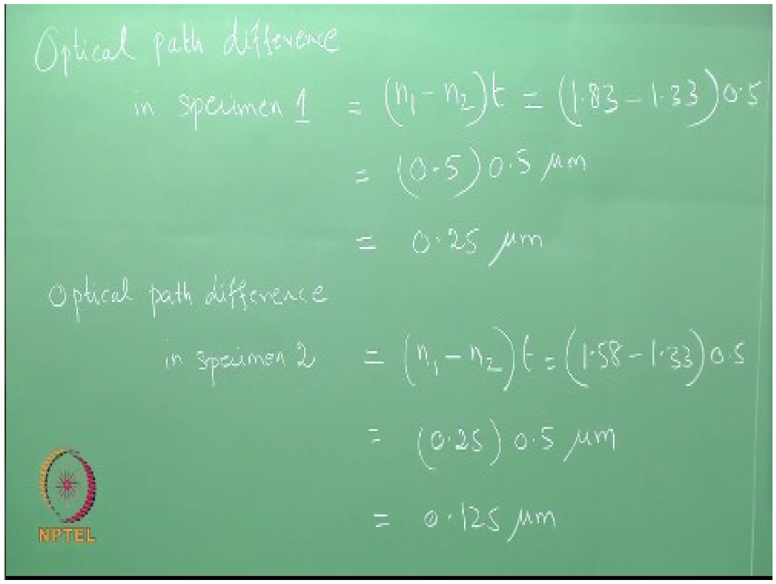

Now we know the formula for optical of difference so for the case of you can say is the specimen 1 $= (n_1 - n_2)*t$, which is nothing but; so we simply substitute this values of n_1 and n_2 for a specimen into this formula; the path difference is the difference in the refractive index times the thickness of the medium so you get the path difference of specimen 1 is 0.25 similarly we can do.

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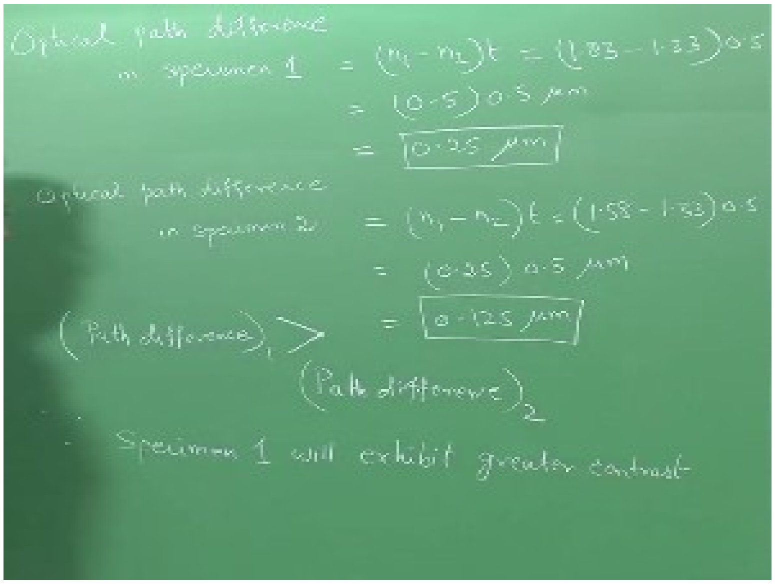

So now you have two values belonging to specimen 1 and then specimen 2. So now you have to think how do we interpret this values, so what is that the path difference exhibited by specimen 1 is greater than path difference exhibited by specimen 2; so obviously you know how to relate this with the contrast, so therefore specimen 1 will exhibit greater contrast. So it is a very simple problem but to in order to bring the idea of phase difference and it is useful we will now move on to problem number 6.

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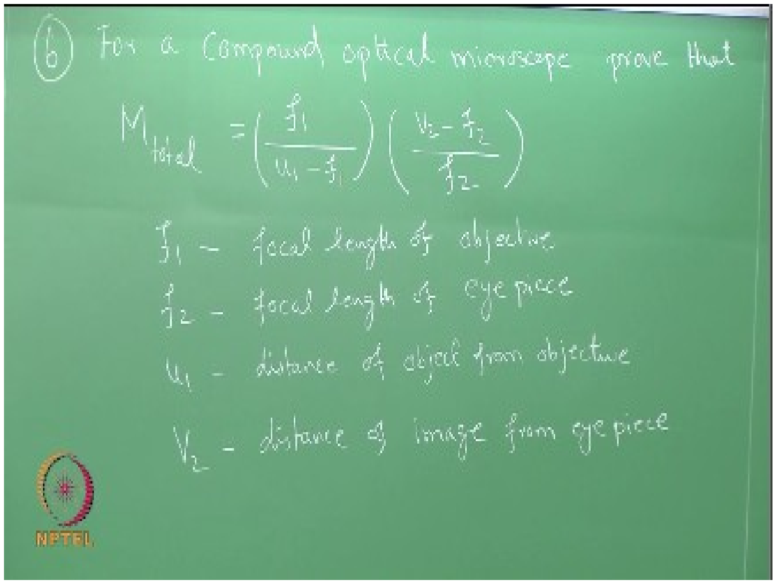

So the question is for a compound optical microscope proved that M total that is magnification total magnification = $(f_1 / (u_1 - f_1))*((v_2 - f_2)/ f_2)$ where f_1 is focal length of objective lens f_2 is the focal length of eyepiece lens u_1 is a distance of object from the objective v_2 the distance of image from the eyepiece, so before you make an attempt to solve this kind of a derivation you better go back and look at the ray diagram what we have discussed in the class.

For an compound optical microscope, if you remember or recall the ray diagram then it is very easy to derive this, so the first step is we know.

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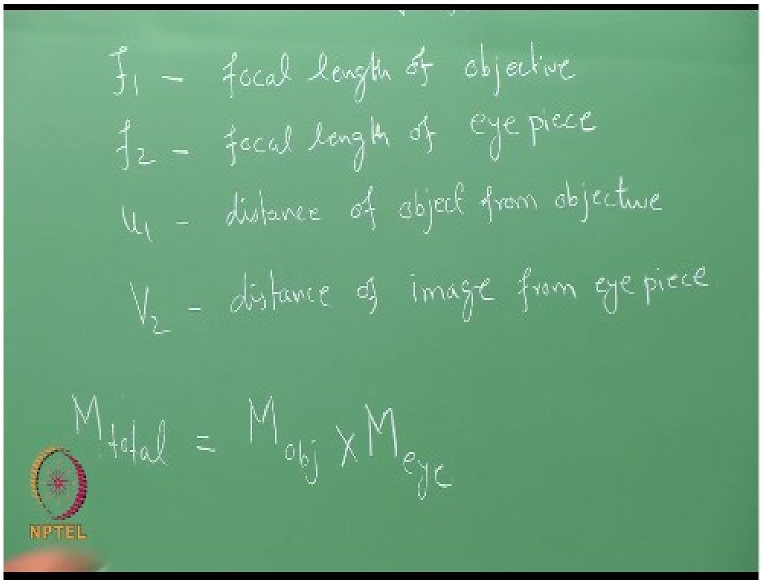

M total is equal to objector and eyepiece so this we know magnification; total magnification = magnification achieved by the objective lens times* the magnification achieved by the eyepiece points, so we also know that from the ray diagram we can write V/U so for objective lens we can write $1 / f_1 = 1/ u_1 + 1/v_1$ so this can be written as $1 / V_1 = 1 / F_1 - 1/u_1$ so what I have written is for an objective lens the lens equation you can write $1 / f_1 = 1/ u_1 + 1 / V_1$, so you can rearrange this to this form then from there you can write an expression for V1, so we can derive an expression for v_1 from this like this similarly so you substitute that v_1 in this equation that is for M objective is $F_1 u_1/ u_1 - f_1/ u_1$, so you write like this $f_1/ u_1 – f_1$ so this you can consider this one equation 1.

What I have done is you basically this is the equation basic equation and from this lens lengths equation we can obtain an expression for V_1 and then I am simply substituting this into this and then I am getting this kind of an expression similarly for eyepiece let us assume that u_2 and $1 / f_2 = 1/u_2 + 1/ V_2$ and we can assume this similar expression you substitute this, so you get this kind of an expression for in magnification of eyepiece.

So now we can compare one two and let us consider this as three magnification total is equal to magnification of objective so let us write like this I will rewrite this here for convenience and then from one two and three we will be able to write M total equal to the expression this is what we have asked in the question, so what you have to remember is again I am telling you before you try to solve this small derivation look at this ray diagram of the compound lens we have seen in the class then you correlate this magnification of objective lens.

And magnification of eyepiece lens geometrically and then verify them and then look at this expression then it is it will be very a simple derivation, so with that I want to stop this tutorial class and we will move on to the next topic on scanning electron microscopy and then we will also take up a couple of tutorial classes involving some of the basic principles after going through the theory and the working details of the SEM, thank you.

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