Industrial Inorganic Chemistry
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Lecture – 50
Inorganic Fibres: Asbestos, Textile Glass and Optical Fibers

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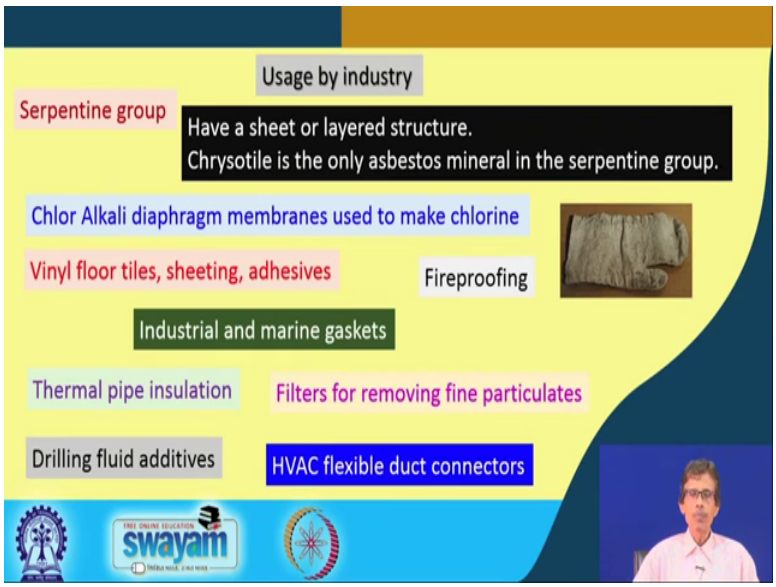

Hello everybody. So, welcome back to the class once again, so where we are talking about the asbestos fibers. And what we have seen that one particular variety, that means, one particular group can be useful for making these particular type of fibers. So, the purpose of this making is that we can have a diaphragm, we know that a particular type of filtration process can be achieved through a diaphragm.

Diaphragm can be a piece of cloth also. So, chlor alkali diaphragm membranes where we can use it can have a typical use as the membrane also. So, the chlor alkali process we already seen earlier in our one of our previous classes, several classes basically we have discussed the chlor alkali process. So, the chlor alkali diaphragm membrane used for making the chlorine. So, there we can use that particular diaphragm and these diaphragm can be made of your this particular asbestos material.

Then we can use this asbestos material as vinyl floor tiles, because these are the corresponding support material because the original material can be of vinyl polymer, but the vinyl polymer can have the support on the asbestos material. So, vinyl floor tiles we

know that the different types of floor tiles or the floor sheets we basically use which is foldable also. Then the floor sheet also tiles are very hard and saw their very thickness is also very high. Then sometimes the vinyl based adhesives are also there, where some amount of asbestos is there.

Then as a very useful fire proofing material, so we can have the fireproof for your walls of the home, then any other places where we can have some chances of catching fire even in the laboratories or the industry, because this particular material the asbestos will not very quickly take fire or catch fire. So, one such example is your gloves that which can withstand a very high temperature, because it can have also the insulation material. So, gloves, a glove made of your asbestos material which can withstand a very high temperature also you can put that glove and we can hold some hot rod also. So, it can have a good heat resistance as well as it can have a fire proofing material also because with this glove you can handle any open fire also.

Then different types of industrial and marine gaskets we can use. So, the different types of industrial and marine gaskets because that whether we can have some part, that means, industrial gaskets which is filling some point or which in some you can have some valves. So, valves we can have some gaskets we know that most of the time it is the rubbery material, but the asbestos can also be a very good material for as the gaskets. Because that asbestos threads we know that we can put in the plumbing also in for the water lines also we can use this as the corresponding thread.

Then different types of thermal pipe insulation, because the thermal pipe is there and we do not want to go for loss in that particular temperature of the thermal pipe; so, we put this particular covering with that of your asbestos material. Then filters for removing fine particles, just now what we have seen in case of your preparation of your chlorine as the membrane making process, or the diaphragm making process.

So, if we can uniformly put those particles or those fibers that is asbestos fibers then we can have some threading of those asbestos fibers, so fine mesh size can be generated such that only small particles of a particular mesh such as your 10 or 20 mesh sizes can pass through that particular membrane others will be retained. So, it can be used as a filtering material that means, the water; that means, the cellulose based filter paper

cannot be useful sometime. So, asbestos based filtering material, filtering membrane or diaphragm can also be useful sometime.

Then one more important thing is that the drilling fluid additives, because when we drill that surface of our earth to get water, to get oil, to get gas, we use some drilling fluid. So, drilling fluid can be mixed with this asbestos material. So, it has some good advantage for addition of this particular asbestos material, asbestos fiber or powder sometime to get a good type of these drilling additives for this your drilling fluid.

Then HVAC flexible duct connector. Because nowadays for this common the heating, that vacuum, then AC thing in the room or the laboratories or the industry places, we can have the in house making of the heating process, vacuum of that particular that means, we want to evacuate some time and that the natural AC process that means, cooling of the air or the heating of the air is required, and we can supply fresh air from the outside we can supply through some duct to the different laboratories, different rooms and different chambers basically. So, we can have the flexible duct and most of these ducts are made of with these asbestos materials; so, very useful use and the consumption of these making this flexible duct connector is with that for making the different HVAC units.

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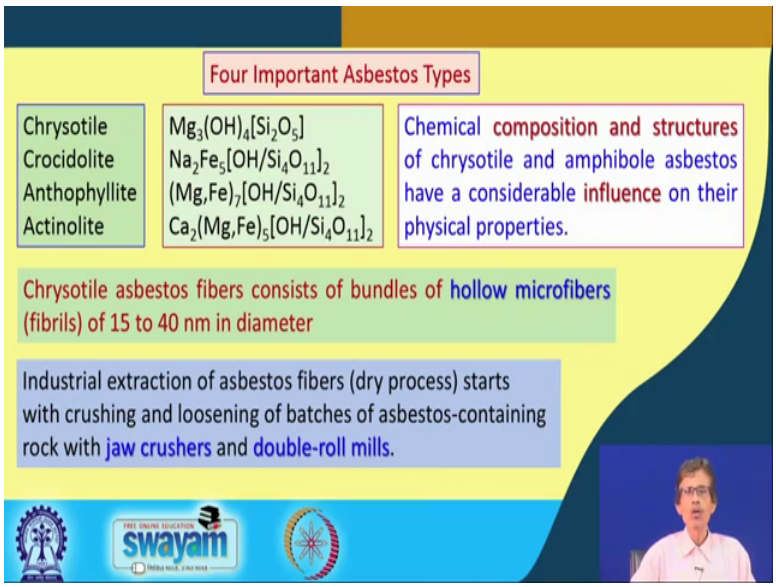

Then what we see that we can have four important asbestos types. What we can find now that we can have four important asbestos types and these asbestos types what we have

seen that by name we can have, so chrysotile, crocidolite, anthophyllite and actinolite. So, these are the names basically and sometimes it can be very difficult also to remember. But if we think in terms of their corresponding chemical composition will always be interested as an inorganic chemist that what should be your corresponding chemical composition of these four different varieties.

So, first one basically the chrysotile, chrysotile basically the chrysotile is your typical material which is basically magnesium silicate. As we all know what we use day-to-day as difficult different types of talcum powder. What is talc? Talc or the talcum powder is nothing but your hydrated magnesium. So, this is also that sort of hydrated magnesium silicate of different structure. So, chemical composition of this material of this asbestos type is typically that of your talc or talcum powder is basically made up of your only magnesium silicate which is hydrated of different level.

Then crocidolite, crocidolite is basically is corresponding one where you have iron you dont have any magnesium you have sodium and iron along with a huge silicate structure. So, all these materials are a very complex silicate structure. So, basically these are silicate materials. So, we are studying we are still continuing with those silicate materials of very useful in the different purposes.

Then anthophyllite anthophyllite is again we bring the first category of magnesium then iron, and of different types of the silicate material and the large number of hydroxy groups are there. So, those hydroxy groups can be the terminal one attached to your silicon or can be attached to your the corresponding metal ions center. Then actinolite, actinolite is basically based on your calcium magnesium thing.

So, when you find this chemical composition, we will always think or talk about the different structures, and those different structures of these materials are of different types. So, chrysotile and amphibole asbestos have a considerable influence on their physical properties. So, the composition and the structure will tell us that no it can have a different physical property as well such that you can have a different structure. So, it can basically modify its characteristics or the physical properties or the physical behavior.

So, chrysotile asbestos fibers consists of bundle of hollow micro fibers. What are those? Those are bundles of hollow micro fiber, so those that is why these are interesting to know what are known as the different types of micro fibers, we known as fibrils. So,

these are the typical term what we use in the biological word also in the bio organic chemistry or the biochemistry we know the protein fibrils. So, the fibrils are hollow microfibers nothing but this. So, you have the very small channel. So, these are the hollow microfibers of 15 to 40 nanometer in diameter. So, diameter is also not very much it is only within 50 nanometer.

So, when we go for these asbestos fibers, so we can have a particular process. So, industrial extraction or industrial isolation can be used through a dry process. How it starts? It starts with crushing and loosening or batches of the raw asbestos materials which are coming out of the rock. So, the rock material is a starting material. So, the bulk rock material we can go for the loosening of those rocks with the jaw crushers. So, jaw is there. So, the jaws we know that the jaws can take out and then remove those fibers or the corresponding micro fibers also.

So, one of these that means two things we use basically the jaw crushers, these are the common instruments industrially people use all the time one is the jaw crusher another is the double roll mills. So, the jaw crusher will separate and double roll mills can roll. And bundle of those particular type of asbestos material like that of our jute material what we get which is also a plant material. So, plant material which we can put as is a very good fiber. So, asbestos is like of that of your jute, and we use it in the double roll mill to for their rolling we can consider this as the rolling mills also.

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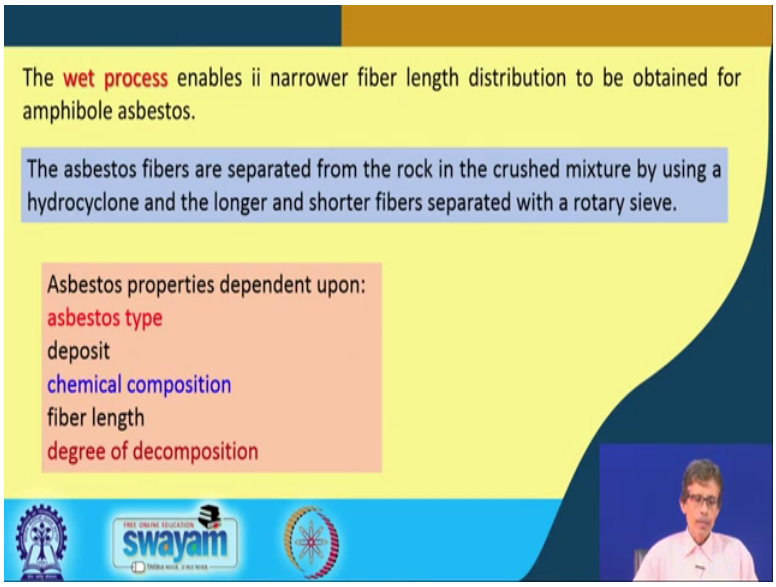

So, one particular process is known as the wet process. When we follow this particular wet process for making these it enables it to for narrower fiber length distribution to be obtained for amphibole asbestos. So, when we make these amphibole asbestos, so we basically give narrower fiber length distribution. So, the distribution so everything is not uniform, but most of the time we will find that one particular variety of fiber length and its distribution will be important to give a characteristic pattern and the characteristic structure. So, we separate it from the rock material how by crushing or the crushed mixture by using a hydro cyclone and the longer and shorter fibers are separated with a rotary sieve.

So, we have a rotating sieving mechanism such that the longer one will be separated from the shorter one. So, shorter will be separated at one point and the longer are separated out from that particular separation process. Now, once we have the different types of these fibers, their microfiber structures, their length, and all these things are useful because a particular type of behavior or particular type of use or particular property of those asbestos materials are dependent upon the type, what asbestos type you have, what asbestos type we are getting from the natural nature or from the natural material.

Then where from we get that particular type of deposit like that of your geographical origin or geographical origin of that particular rock variety. Then obviously, the chemical composition when you go up to that end, either you have magnesium, whether you have iron and how much of silicon is there, and the silicon structure.

Then the fiber length as we have seen just now the shorter length and the longer length we can separate it out, so we can use for one particular purpose the shorter fiber length, and the longer one for the other purpose, then degree of decomposition if we want to degrade this. If we want to get the powder material out of those materials, so it can also be dependent on the strength of that particular material, and how quickly we can degrade this particular material for our use.

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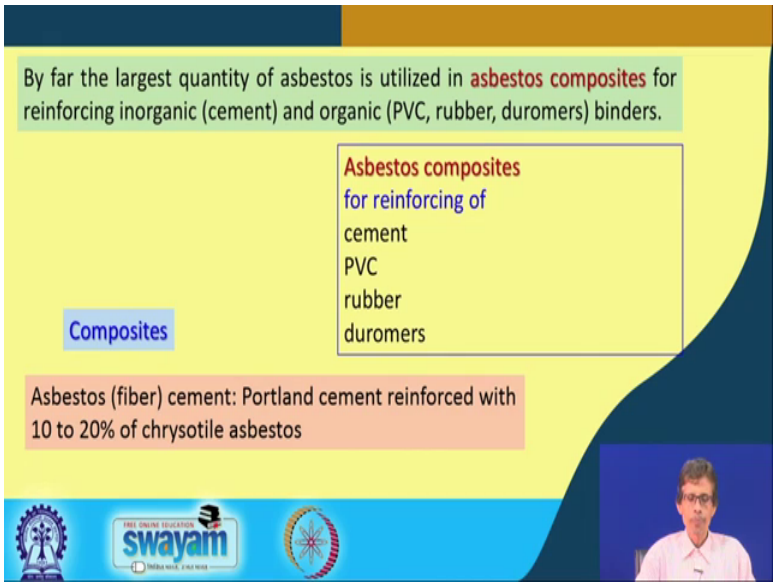

So, the largest quantity of these asbestos are the different types of asbestos composites we can make. So, what we see now that we can use that we can put those asbestos material in some other material like that we know that in metal science or the polymer science that we make some composite material, where the basic material is your polymeric material. And we put something else such that we can increase the strength, the durability, the structure, the its corresponding affinity for giving different shapes will be changed.

So, when we use asbestos as a composite material or composite item to get the composites is known as asbestos composites. So, these asbestos composites are utilized, the most important application is our cement application, because we will be seeing maybe in our today's class or in the next class how we make cement is the most useful material what we make the inorganic chemists keep the corresponding industrial sector because we use it large amount of cement we use it, but the basic idea or making up all these things is your typical knowledge of inorganic chemistry.

So, how we get that cement material? So, right now when we are talking about this asbestos material let us know how we can improve the strength of that particular cement material. So, if we put that means, you can have a composite, why we make these composites again in particular terminology, these are the general terminology. The reinforcement that means, we are increasing the strength of that particular material such

that we can have some impregnated thing that like that of our backbone type of thing, when we put the rod in the concrete, it changes the corresponding strength of this column of the building. So, in some other form, the reinforcement for the concrete material not only by the addition of the gravels or the sand, but the addition of the asbestos material will giving you the corresponding cement as the asbestos cement. Then some organic material we can put inside it.

So, the organic material when trapping this asbestos material as the binder material as the organic binder that means the polyvinyl chloride then other synthetic rubber or the natural rubber such as that of your neoprene rubber. And some of the duromers that means, the polymeric items having higher durability is known as duromers. So, duromers can have your binders which can trap those asbestos to use these composites. So, where we use basically thats why the reinforcement can be achieved for cement, can be achieved for PVC, can be achieved for rubber, and can be achieved for the duromers.

Then how we define a particular type of composite any kind of composite is a general term. So, the composite when we think in terms of the asbestos, we can consider it as asbestos composite. So, we supply the fiber the asbestos fiber. When we supply these asbestos fiber to the cement material, cement is the powdery form what we will see in our next class possibly that the powder material when is mixed with water and we allow it for some setting time, we get something but we can get the plaster of some building or we get some the corresponding concrete.

So, when asbestos as the corresponding fiber is given, so we take one very useful or well known cement type is known as the portland cement. So, this portland cement can be reinforced with up to a 10 to 20 percent introduction of the asbestos material and chrysotile asbestos is added such that you can improve the corresponding cement material when we go for its corresponding met as the corresponding concrete making or any other type of use.

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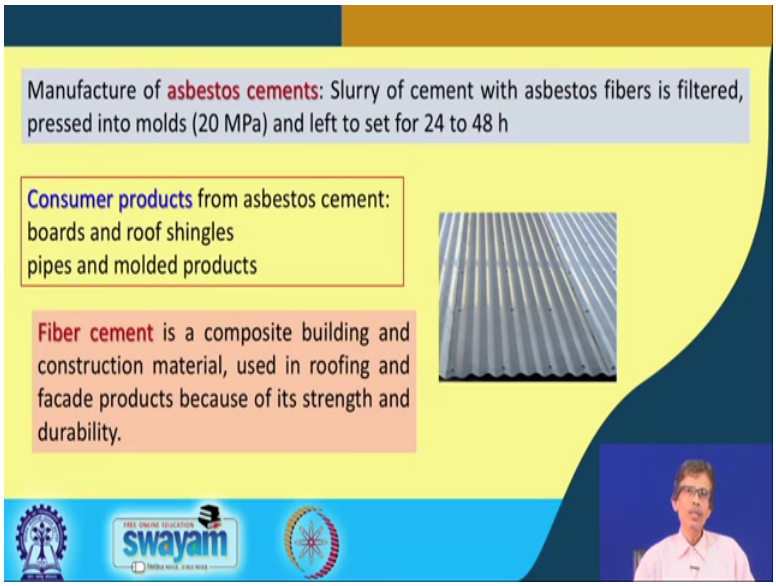

So, we see now that how we make this asbestos cement. So, if we get that, because this is a dry material that asbestos itself is a dry material, after dehydration like that of your zeolite weight we see that we can get this asbestos for this particular purpose that you can have this asbestos cement. So, you get that the slurry of the cement. So, asbestos will be put inside with asbestos fibers is filtered. So, slurry of cement with asbestos fibers is filtered placed into molds at a very high pressure and left to set for 24 to 48 hours. So, you see within 1 or 2 days it will be set. So, asbestos cement material or asbestos concrete material can be set if we have the addition of asbestos material to the slurry of cement.

So, different types of consumer products we can make out of this asbestos cement, where this asbestos impregnated cement rather to make the different types of boards, different types of roof singles; that means, asbestos roofs we all know that we can use as the asbestos sheets for roofing, then the different types of pipes and the molded products. So, one such is your the corrugated type of asbestos sheet, what we can use as the roof material for making houses.

So, we gets the idea that asbestos material is a typically fiber material. So, we get a general term for this cement is the fiber cement. So, what is that fiber cement fiber cement is therefore a composite building or construction material used in roofing and

facade products that means, you can have the plaster of the walls also because of his strength and durability. So, we can improve.

So, is a basically a value addition we can improve the corresponding quality of the cement because we know will see also that large types of a large number of different types of cements are there, where your silica content is different, where iron oxide content is different, our alumina content is different or also the corresponding addition of slags giving you the slag cement.

So, if we have a pure variety of that cement powder and cement powder we putting water we get the slurry and that is fixed. Now, after the addition of this asbestos fiber, we get the fiber cement which have higher strength compared to your original structure what can be obtained from the powder cement.

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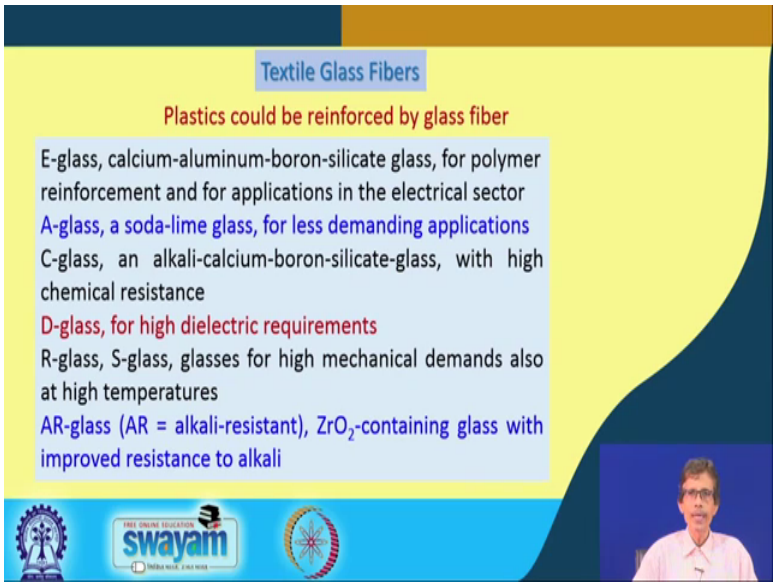

Then we will see something as your glass fibers, which is also a very useful fiber inorganic fiber what we can think of and we can use this or we can make those fibers like that of your textiles also. So, we can put in the textile material also or the textile like of these fibers we can have, like that of your plastic material; so, the polymeric material the nylon material.

So, the plastics could be reinforced by glass fiber. So, some plastic material if we can put or if we can put inside the corresponding reinforcement material as your glass fiber, you

can have a different type of material we can obtain. So, large number of this type that means, the glass fiber in pregnant plastics or the textile fibers in can have. And now to simplify that nomenclature of all these things instead of giving a complicated name of geological origin, we can have the typical A, B, C, D type of nomenclature.

So, the first variety is known as E-glass. What is E-glass, E-glass is nothing but your textile fiber glass. So, E-glass will be made of a particular type of glass, which is calcium aluminum boron silicate glass, because the glass we know a particular variety of your sand silicon dioxide only. So, when we put boron in it, we get the borosilicate glass.

Then sometimes the quality of that particular glass can be improved by the addition of aluminum as well as calcium. And it can be used for your polymer reinforcement and application is in the typically in the electrical sector, because if we have this glass material we can have the insulation that means, the corresponding covering of the simple wire. The electrical wire basically, because we want to have the typical insulation of the electrical wire for high voltage transmission also.

So, the electrical engineering industry can be very much dependent on this particular type of E-glass variety for its reinforcement in the polymer for coating of the wires. Then the next one is the A-glass, A-glass is the very basic glass what we know that which is obtained from your sodium silicates, which your soda-lime glass. So, sodium silicate as well as some calcium based lime is added, calcium oxide is added or calcium carbonate is added; so, is it can have the less demanding application, but you can have the very basic material you can make for making this soda lime glass for it.

So, the third one is basically apart from your lime and alkali that means, soda and lime you put boron, boron already we know that boron can improve the quality of the corresponding glassy material. So, it will have a high chemical resistance that is why the borosilicate glasses we use that that of your corresponding, where the glass wires for our laboratory use or industry use for the chemical industry.

Then you can have the D-glass, another variety after C is the D for high dielectric requirements. So, you change simply by the corresponding glass type then we can have R-glass, S-glass and all different sorts of glasses we can have, where you can have a high mechanical demand at high temperature. So, it can have high strength mechanical strength will be more and it can withstand a high temperature also.

Then the other variety what we can think of that one is known as alkali-resistant glass, which is known as air glass. So, you can put already we have seen that it can have a very high temperature withstand if we use zirconium dioxide or zircon. So, zircon containing glass with improved resistance to alkali.

So, we can have all varieties, one can be of acid resistance, one can be of alkali resistant, one can be of temperature resistance. So, these things can be very useful and some will be simply chemical resistant that means, any other type of chemical can be handled with the use of that particular material for making of any type of pipe or any type of other flexible material for use.

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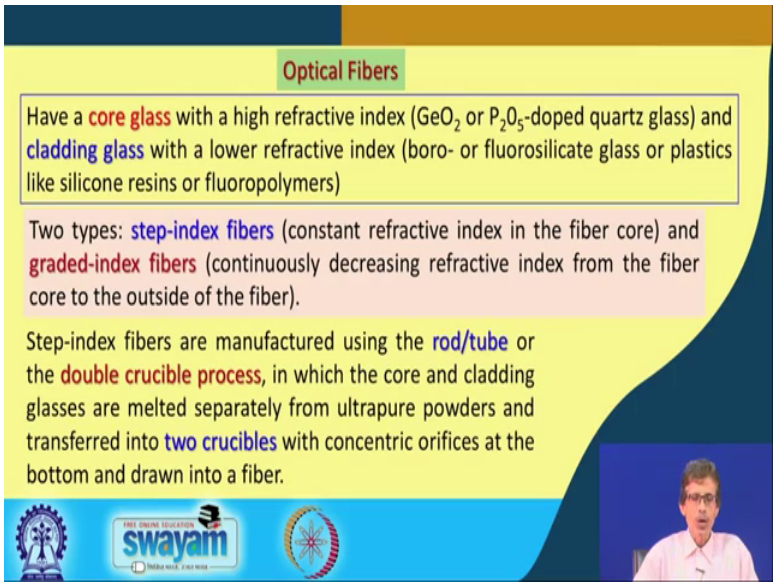

So, the other one other most interesting one is our use of your optical fiber, so that optical fiber what we know that optical fiber cable in the communication sector, through electronics engineering people and electronics industry as well as the telecommunication industry is very much dependent on this particular fiber, but it has a typical origin of inorganic origin.

So, the industrial in organic chemistry can also be benefited from the knowledge of making of optical fibers, how industry can start for making this particular type of optical fibers. So, what is that optical fiber, why it is specially named and specially designed. So, it can have a core glass structure. So, so the core of this material the fiber, it can have a good core and this core is basically made up of glass with a high refractive index that

means, germanium dioxide or phosphorus pentoxide doped quartz glass, is a special variety of glass, we may not get it naturally from the market.

So, it is a special variety of glass and the price of this glass would be therefore, definitely higher, because you improve that in terms of its now high refractive index such that you can have the total internal reflection. You can have a material prism like material and you go for total internal reflection.

So, total internal reflection will carry the information, carry the light, carry the message with that of your optical fiber. And one is your cladding glass that cladding glass is covering your core glass. So, the cladding glass will have a lower refractive index. So, any other type of normally used glass, what we use in the laboratory also can be used such that your borosilicate glass or the fluorosilicate glass. Sometime we can use the plastic material even also, like silicon resins also and the different types of fluoropolymers also, it is not that you can you have used other glass also, but your core is of different types.

So, core glass is the important factor for making this particular type of optical fibers. So, we can have two steps basically for it, one is your step index fiber, so two types they are; so step index fiber and another is the graded index fiber. So, step index fiber you change the index of your refractive index in a stepwise manner.

So, constant refractive index in the fiber core; so, you cannot change that particular refractive index and another is the graded index fiber continuously decreasing the refractive index from the fiber core to the outside of the fiber. So, whatever refractive index you have at the core which is decaying down, when you reach to the outer surface of the fiber, so that is the particular type of idea and particular type of methodology can be used for making this particular type of optical fiber.

So, step index fibers what we use or what we make are manufactured by which way. So, step index fibers are manufactured by using the rod and tube or the double crucible process. So, the process of making this particular step index fiber is by rod tube or the double crucible process. In which particular process the core and the cladding glasses, because we have seen that we can have two types of glasses; one is the core glass, another is the cladding glass; one is that the core and another is covering it or in the molten state.

And they are in the molten state separately from ultra pure powder, because impurity will be a detrimental thing for all making of all these things. So, the purity is very high that is why the cost of these glasses are very high, apart from its involvement of Ge O 2 or P 2 O 5. The purity matters also, because we are dealing with something of high precision material. So, this high precision material you can have only if you have 99.999 percent purity with respect to a particular variety or a particular material. So, the core of this particular one is formed from the ultrapure powder we use and that ultrapure powders are transferred into two crucibles.

So, you should have a very good idea or very good knowledge about what is known as crucibles we know. The very small crucibles, the nickel crucible, the porcelain crucible, the sintered base glass crucible, use in the day-to-day laboratory classes in all chemistry laboratory classes we use. So, if we use it in a bigger size, it will be of semi industrial scale; but if we go for a much bigger size, it will be of industrial scale.

So, your container for doing all these reactions will definitely be the crucible. So, this particular case we can have two different two types of crucibles we can have with a concentric orifice. So, you can have a crucible type of structure that will see in our next class that what sort of these particular crucibles we can have.

But the thing is that in the molten condition, because you can put the temperature high for those crucibles. So, the material within this crucible will be in the molten condition, and once you allow it to pass through some orifice. So, you can have the concentric orifice through one will go that particular core glass material, and on the outside will allow to pass the corresponding cladding glass material.

At the bottom of that particular crucible, so crucibles are not having no outside passage at the bottom, but it will have the passage from the bottom. And when it is passed, it is then cooling and the cold thing of this fiber is giving you the corresponding preparation of this optical fiber. So, it is coming out as a thread out of this. So, one thread is coming out at the core thread covered with the cladding glass and which will be coming out at the bottom of that particular crucible.

So, next day in our next class will consider the corresponding design of that particular crucible and how we utilize these things are two molten conditions within two concentric crucibles can be utilized for making of this particular type of optical fiber ok.

Thank you very much.