Glass Processing Technology
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Lecture – 07
Glass Coating Technology

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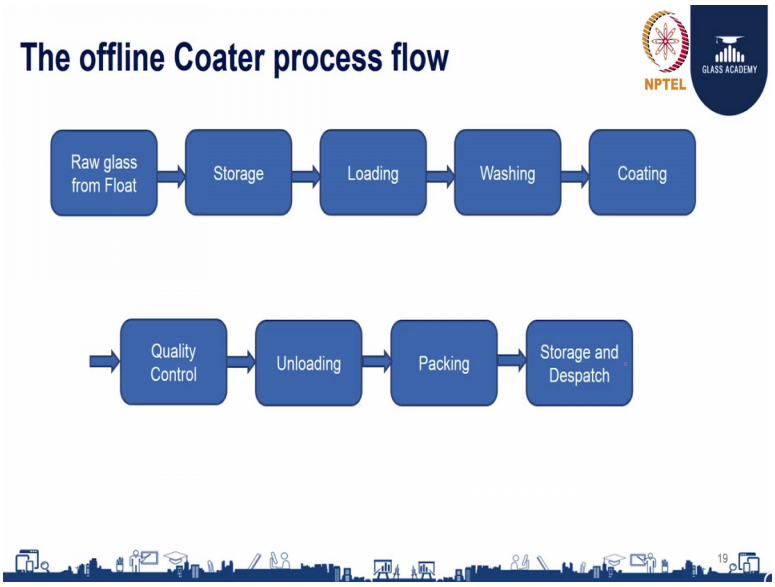

Now, let us understand you know overall coater plant how the coater offline coating process happens at a broader level. The process is as we said the raw glass is received for the float line, and then it is taken for storage, and it is taken into the line and it is loaded. And the first process is washing where in we clean the glass surface that is needed that is going for coating, and next the coating process happens. Post the coating we have quality control, we unload the glass and then it is sent for packing and then it is stored under a special customer. This is the broad overview of the process flow of coating.

Now, let us understand each of these steps in detail.

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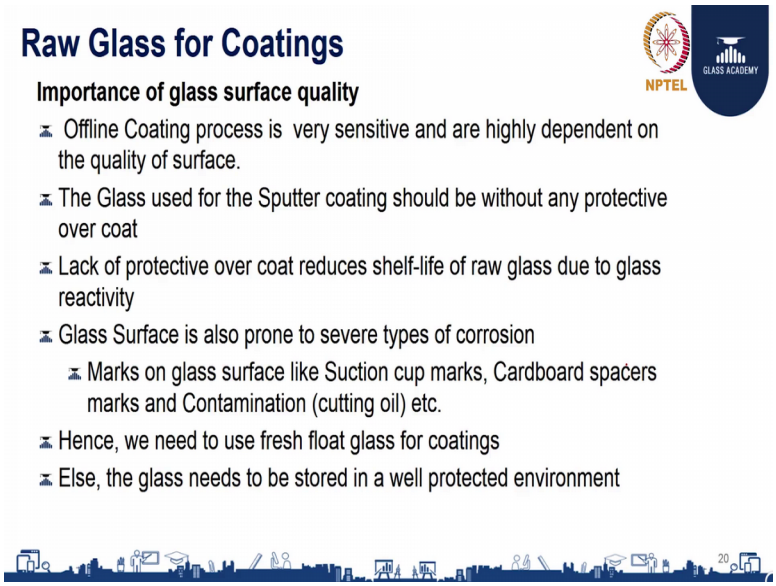

The raw glass the glass from the raw glass for coating, the surface of the raw glass is quite critical for this coating process. See as such coating process is very sensitive and it is highly dependent on the quality of the surface of the glass, pan glass. So, the pain, the pan glass sputter coating should be without any protective over coat, it should not have any over coat.

And so since by virtue of not having over coat these raw glass can be you know assessable for reaction to the atmosphere. So, the shelf life of raw glass is critical here. So, or on top of that raw glass is also prone for such corrosions like suction cup marks and no space of mask and oil traces. So, it is advisable to use fresh class from the float let for this coating process, if it is not possible then the glass has to be stored in a protective environment so that no the glass surfaces protected and can be no used for coatings. This is highly critical.

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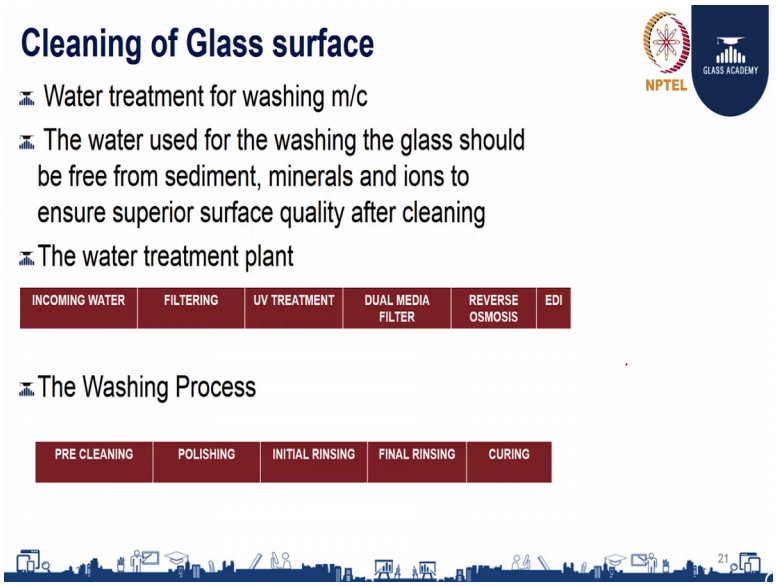

Next process is washing. For the washing process the water quality is extremely critical. So, the water should be free from sediments, mineral and ions, and for in order to get the superior surface quality after cleaning. So, the normal conductivity of the water should be in the range of 0.1 micro Siemens per centimeter cube, and the typical water treatment process what is recommended is you know once you have the raw water it has a initial filtration it has to go for UV treatment, dual media filter and ye reverse osmosis process, and electro deionization process. And the final quality of water has to know be separate for the directly to the washing machine for the complete cleaning.

The washing process has a freaking pre cleaning process, your polishing section by which we prepare the surface of the glass for coating, and then initial rinsing, final rinsing and curing. The EDI water is generally given directly to the final rinsing zone.

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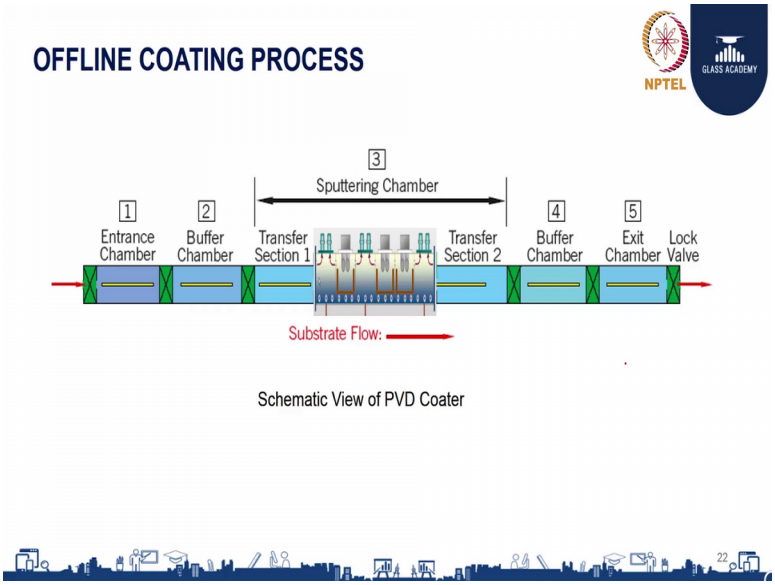

Now, moving on this is the schematic view of the PVD coater set up. Here, we have the blocks which are said in terms of entry chambers, buffer chamber and then the sputter chamber, the exit buffer and exit chambers. So, this is the series of blocks.

As I said the entrance sputter chamber is (Refer Time: 03:53) ultra high vacuum in the range of 10 power minus 6 millibar. So, this vacuum range is achieved in some zone steps. So, the entry chamber and the buffer chamber they support in terms of achieving this you know process vacuum. So, the grass is moved in term in steps to achieve this high vacuum chamber environment. So, entrance chamber can be know it is from the atmospheric pressure you can go down to 10 power minus 2 millibar. The buffer chamber is generally is maintained at 10 power minus 4 millibar, from there the transfer section operates at a process vacuum.

So, the glass is moved in steps in and a vacuum is built in steps downwards here and the exactly the reverse process is happens in the exit section here. From the transfer section we come to the atmosphere in steps. So, from 10 power minus 6 millibar range we come to buffer chamber where is 10 power minus 4 and then the exit chamber at 10 power minus 2 from there it breaks down to the you know atmosphere where the venting is done, and then it the glass is transferred to the know atmosphere for the unloading section. So, this is the basic know schematic view of the entire coater plant as such. And let us see the sputter chamber in more detail here.

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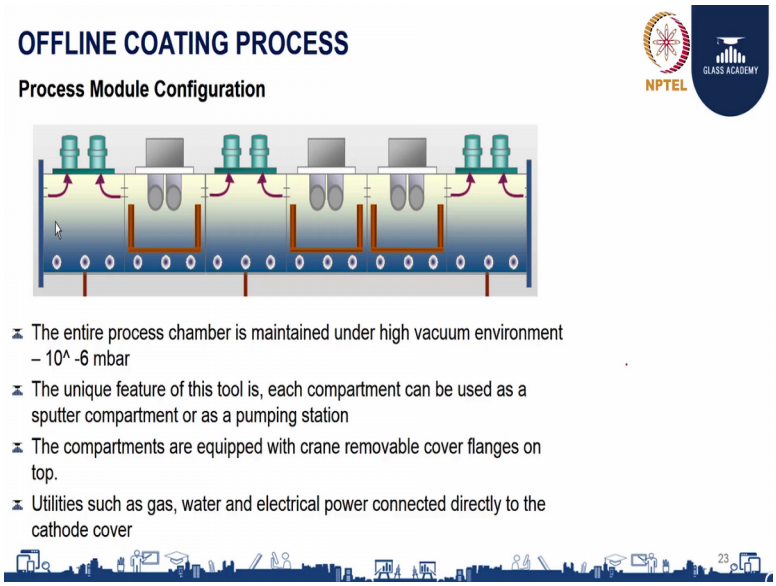

First we will see the entire process model configuration where this entire process module is maintained in under high vacuum environment. We will see here know the pump compartment as well as the cathode compartments.

As I told this is the entire process chamber is maintained by high vacuum. The unique feature is no this universal chamber, it can be it can accommodate both the pump as well as cathode compartment and it can be re configured as per the needs of the process and also the product needs. So, and the compartment leads are equipped with know, the removable and cathode are complete can be removed with a crane and they can be taken for maintenance, and replenish back. And all the utilities are needed for the process into the process gas. The cooling water and the electric power connected directly to the cathode cover. So, this is generally how the process the entire process model configuration is built.

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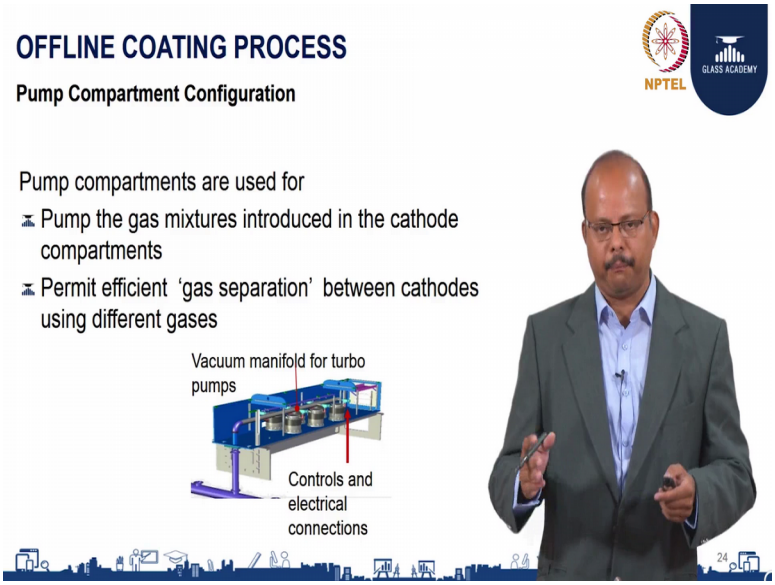

And let us study the pump compartment in more detail. The pump compartment is a one which maintains the vacuum, process vacuum and also ensures that that there is a good gas separation between the cathodes which use different process gases. So, it as you know, it as a pump pre vacuum pump pipe which is directly connected to the pumps which is mounted on to the lids.

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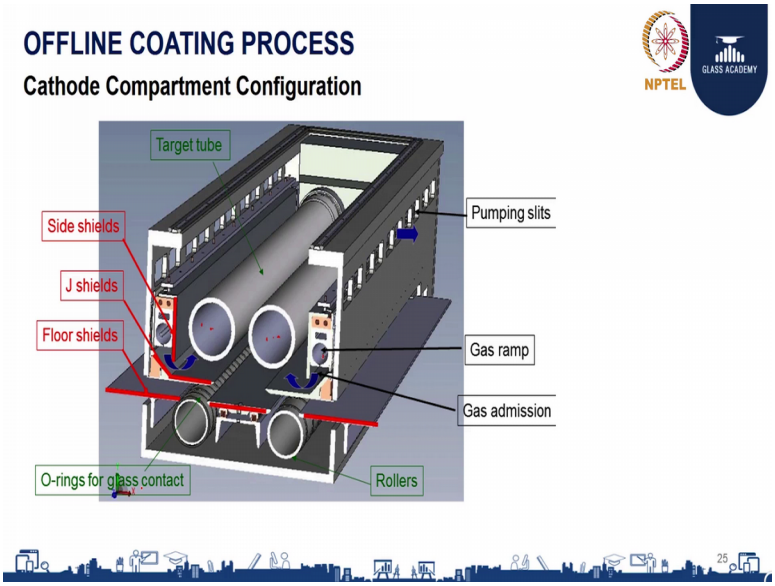

Next is that cathode compartment. Here you see the section of the cathode compartment. As you can see the bottom rollers are the ones which are conveying the glass at a fixed

line speed, the two cylindrical tubes that you see in the top these two tube, these are the ones are the target materials the circumference of these tubes has a target material that need to be deposit on the glass.

What we also see here is the environments where we have the shields which are protecting the sputter the sputtering actually focusing on the actual width of the glass that needs to be exposed. And we also have a protection shield in terms of floor shield which protect the coating from falling on to the rollers and also to the surrounding environment. And we see the pump slits which enable the process gas to be bummed out to the adjacent pump compartments. And the gas ramps, these are the gas ramps through which we pump in the gas that is required for the process, and yes and no the process rollers has a over rings which ensures that the minimum contact of on the glass. So, this is a basic you know sectional view of the cathode compartment.

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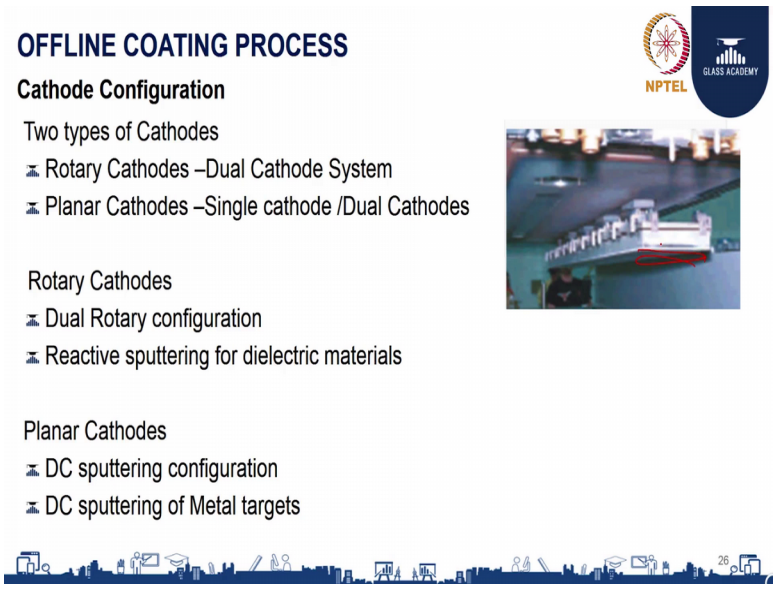

In terms of cathodes we have two types of cathode, one is the rotary cathode which is the node dual AC system, and second is planner cathodes which is the single or know which can be single or dual system.

So, generally the rotary cathodes are used for reactive you know sputtering of dielectric material and this is a typical no cathode rotary cathode that you see in the picture here. And planner cathodes they are generally used for metallic no sputtering and this is a typical section of the no planar target that you see. And this is the specific material that

needs to be deposited glass. This is fixed of a rectangular tile on the planner cathode surface.

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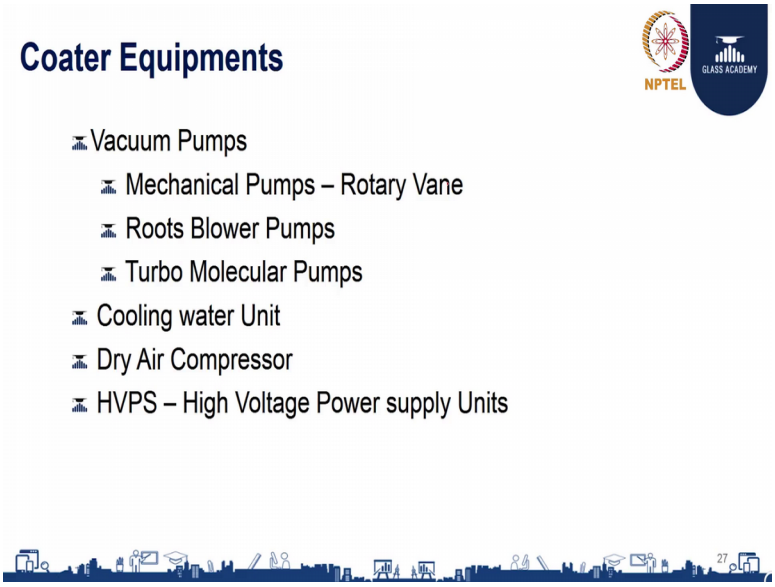

Moving on supporting the basic coater we have vacuum pumps which we need to be in 3 stages we have first the mechanical pumps which are rotary generally rotary vane pumps that operate from the atmosphere to a no 10 power minus 2 ranges. And from there the root blower pump which support the backup which act as a backup pump for the mechanical pumps and in the pump lids we have turbo molecular pumps which maintains the high vacuum of 10 power minus 6 millibar range.

And since this process happens generate heat inside the coating chamber; we have cooling water unit that supplies the cooling water to the coating environment, the shields and also to the pumps and also the power supply units. The dryer compressor this is needed for to know for the bending cycle that is at the boat, entry chamber as well as the exit chamber. And power supplies due this connected for each of the cathode has individual power supply unit connected and this could be a either AC power supply or a DC power supply it depending on the cathode configuration.

So, now, coming back to the let us have a recap of the products that we do in terms of offline coating process.

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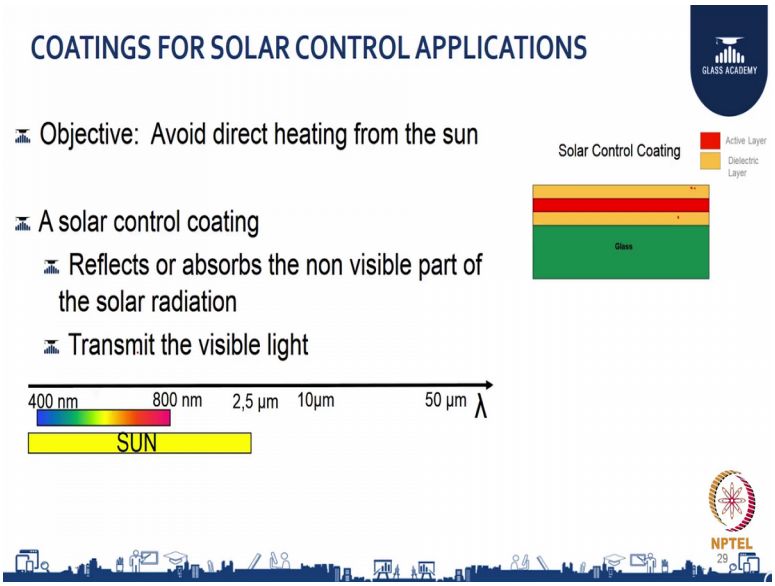

Initially we said we have two types of major applications in terms of you know building exterior, one is in terms of the solar control, second in terms of low e.

First, coatings for solar control applications. So, this objective is to avoid direct heating from the sun and. So, the coating functionality is it reflects or observes the non visible part of solar radiation and transmits the visible light inside the building. So, the typical know layers could be know it could be a 3 or 5 layer coating. So, it will have a basic under layer, a active layer and a over layer.

So, the under layer insures that the coating is know yes, idea rig into the glass is sticking to the class. Active layer is one which gives the functionality of coating. And the over layer is the one which protects against you know atmospheric effect and you know handling and know mechanical aberration.

So, as I told on the solar control coating generally cuts down the solar radiation which happens in the visible, in the visible and the near infrared range.

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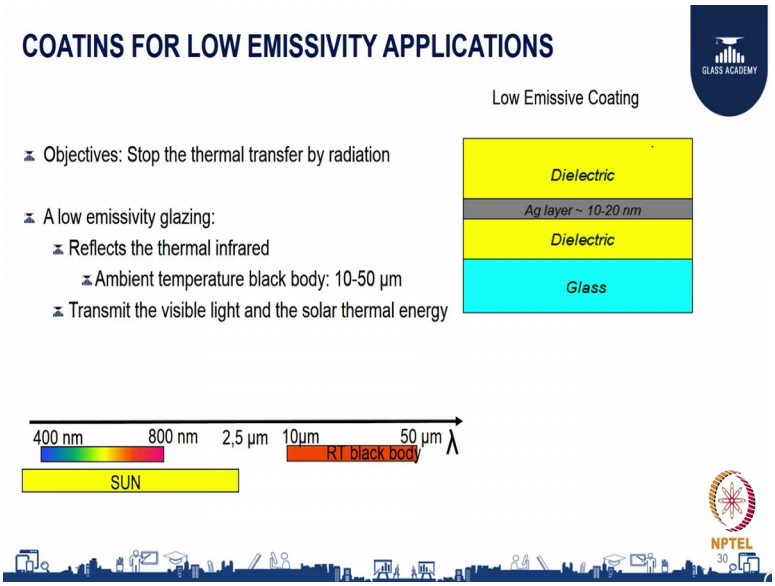

Next is a coating for low emissivity applications. The objective here is to stop the thermal radiation; thermal transfers that happening by radiation. So, here you know these again could of 5 7 11 17 20 layer coatings, depending on the product that is offered and it selectivity or the performance.

So, you will have a dielectric layer and a functional layer which could be a silver based coating, and top of it we will have no more dielectric which protects the silver layer against the atmospheric effect. So, low emissivity glazing it has a no, it was the thermal infrared range, so the black body spectrum. So, it works in that range and also it transmits the visible light and solar thermal energy into the building. So, this is the area where we will have you know functionality of our low emissivity glass applications.

Now, let us move on to understand the quality control that is applied on the coating the glass.

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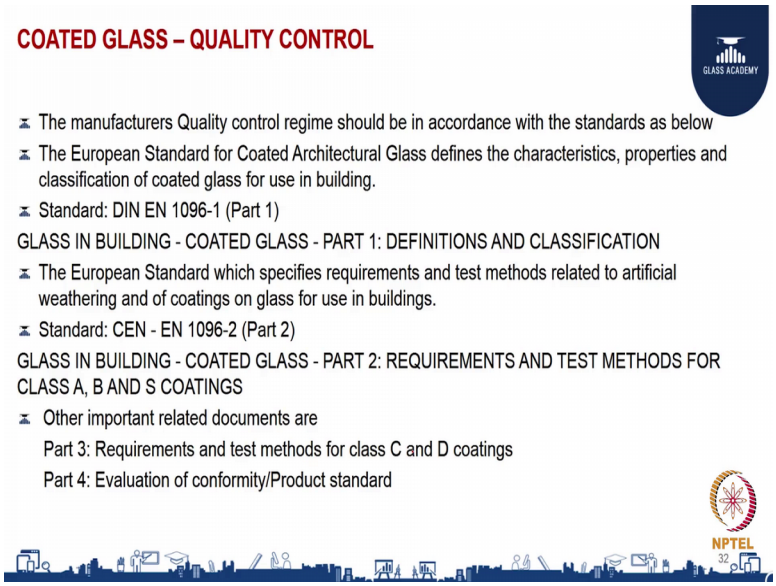

So, the quality regime will have to be for the manufacturer quality regime has to complain with the standards or of European standards as below, which is EN 1096 part 1 which says about glass in buildings of coated glass. And it says about the methods related to artificial weathering of coatings on glass for use in building applications.

And also the second part is part two there it talks about the requirements and test methods for class A, B and S type coatings. And other important related documents could be related to test methods of class C and D coatings; and evaluation and non conformity evolution of conformity and product standard that is part 4. So, these are the basic compliances that we need to establish to the standards in terms of quality regime in the production process.

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So, the typical the quality control that exists are in terms of in the line. We will have color measurements in line which measures the optical mainly that the transmission of light in inside the coating chamber. This is useful for production dissents in case of multi layer coatings, and also they provide information related to the individual layer that is you know sputtered on the glass.

And we will also have a ex-situ measurements at the end of the line where we will have a spectrophotometer that will travels across the width of the glass. Here the glass measurements will give us one on the glass side, coating side, in terms of transmission and reflection the L a b across the width of the glass and this is generally used to control the quality against the specifications of the product.

And there will also on top of this we will also have a visual inspection since the coating process also no involves spurt, the thin film coating also creates no derby and other defects on the glass. We not have a additional visual control which will have manual inspection under simulated daily condition. And it will control surface defects like debris, pin holes, breakages and other aspects.

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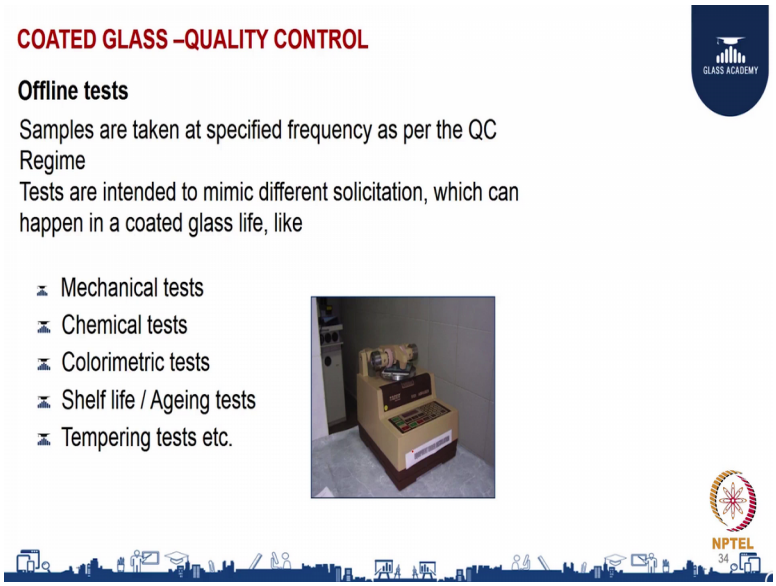

So, apart from this online test we should also the quality regime will mandate taking samples at periodic intervals as per the specific frequency, as per the standard and also the product requirements. And these are intended to mimic desolation which can be you know which can happen in photo glass like mechanical tests, chemical tests, colorimetric tests for the shelf life aging and tempering tests. So, these are test that is mandatory to check for the durability of the glass for the entire product life cycle.

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And once the quality control is the quality glass passes a quality control, then it is unloaded stack and it goes for packing. The offline coated glass you know standards sensitive to atmospheric conditions. So, hence it is recommended to protect during the storage and transit to the customer locations.

So, the types of packing will depend upon the exact product that you use, and the surface treatment that the manufacturer uses and also the local manufacturing conditions. Typically the packing is done by ceiling the edge protection tapes with adequate quality quantity of desiccant, and transportation of coated glass over high sea may require special aluminum foil wrapping to prevent oxidation.

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