Welding Processes

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Adhesive bonding of plastics

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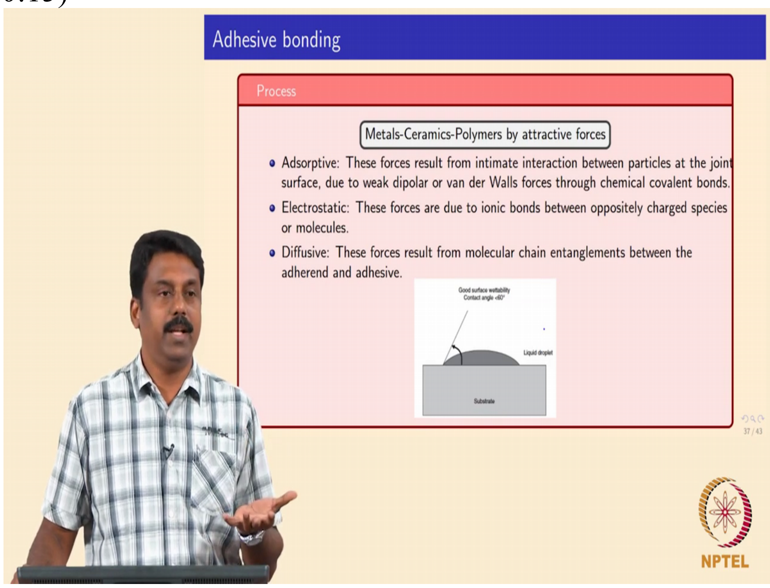

So then we will move on to the last, adhesive bonding. It is the last welding process I am going to teach you. okay. So adhesive bonding. So thermoplastics, they are all you know welded using the processes I taught you in over one hour. For thermosetting polymers, the process what I taught you, hot plate or induction or implant, ultrasonic, vibration welding, and they are not really used for thermosetting polymers. Thermosetting polymers are all joined either by adhesive a bonding or by mechanical fasteners. Okay.

So adhesive bonding is also commonly used for plastics and polymers. Nowadays even for metals. Right? So the adhesive bonding, the principle works in a very simple, right? So it can be you know absorbing. Adsorptive means what do we mean by Adsorptive? You form a very weak force between the joints we make okay so there can be chemical bonds. Okay. And I create a van der waal's force between the the adhesive and the interface to be joined. Okay.

So that chemical Bond is mostly in covalent bonds. So adsorptive or like you know you have a glue in your school days, right? You always carry a glue bottle. Is not it? So those glues they create a weak van der waal's force by forming in a covalent bond between the aggressive and to the interface to be joined. Right? So generally they are adsorptive forces are weaker. Okay. So we can also make slightly stronger joined by making an electrostatic joint. Okay. So electrostatic joint, generally they create ionic bonds. So ionic bonds between the interface to be joined and with the the adhesive you are welding. Okay.

The strongest bond we make, right that is by diffusive. Okay. So diffusive joints means generally the the adhesive we use, the molecules diffuse to the the polymers to be joined and we make more they are single diffusible layer at the interface between the adhesive and the filling interface. Okay. So diffusive joint means it result of a complete molecular chain entanglement between the filling interface and the adhesive. Okay.

So the most of the common adhesives we use, they are all adsorptive. They make weak covalent bonds or a dipolar using van der waal's force. So the electrostatic and the diffusive joint, these are 3 major mechanisms by which we develop adhesives. So by having a diffusive bonding, it is the best we can have. Okay. But it is very difficult to achieve. So most of the cases if you have an electrostatic with an hydro adsorbing joints that is okay.

The main important characteristic of adhesive is wetting. Okay. So the wetting angle, so the L is less than 60 degree. If it is more than 60 degree, so then it is not advisable to use that. So the wetting angle should always be less than 60 degree, otherwise it is not going to wet the surface. Yes. So the important characteristics of adhesive, that should be the contact angle, wetting angle should be less than 70 degree. Right? And then it should work with this principle.

To be (())(4:06) for diffusive joints but most of the adhesive as they fall into these 2 categories. It is clear? Adhesive bonds. Okay.

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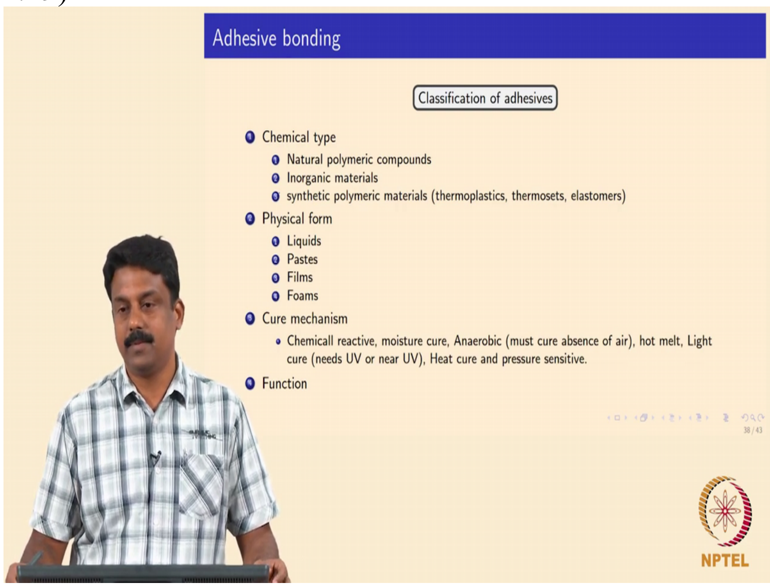

So how do you classify the adhesives? We can classify in various ways. So chemical type or physical forms or cure mechanism, how you cure that or a function. Right? So the chemical types, so now it can be natural polymeric components, okay inorganic materials, or synthetic polymers like thermoplastic, thermosetting, the elastomers. Nowadays we have all the high-temperature glues. Even those are all thermoplastic. Okay.

Materials you heat up and then deposit, it becomes hard extrusion. The process we saw extrusion joining, right? So you melt and extrude the thermoplastic filler and the joining interface. Right? And physical forms, it can be liquid passed as films, foams. Okay. So we can use, the cure mechanism is very important. So we can classify the adhesives based on the curing mechanism you know by chemicals reaction. Or a moisture cure, we need to add some water. Anaerobic.

Anaerobic means you need to cure in the absence of air. You need to create in a vacuum so that in queues and it can also melt, hot melts, hot guns for example or by light, phototherapy. Okay. So you can have an a UV lamp and then UV reacts with the polymers and then the molecule entanglement can take place by the induced reaction or you can also use microwave. Microwave curing also can be done. Or you can also classify based on the function.

So adhesives if adhesive is used for joining alloys, okay. So that is used to join dissimilar materials or dissimilar material with metal and polymer. So we can classify based on the function as well. Right? It is clear? Good. We quickly move on. So in the adhesive process, the curing is very important. So curing can be done as I said, there are various processes. So by chemical reaction or moisture or by light. In most of the cases, the curing is done either by light or with heat, okay.

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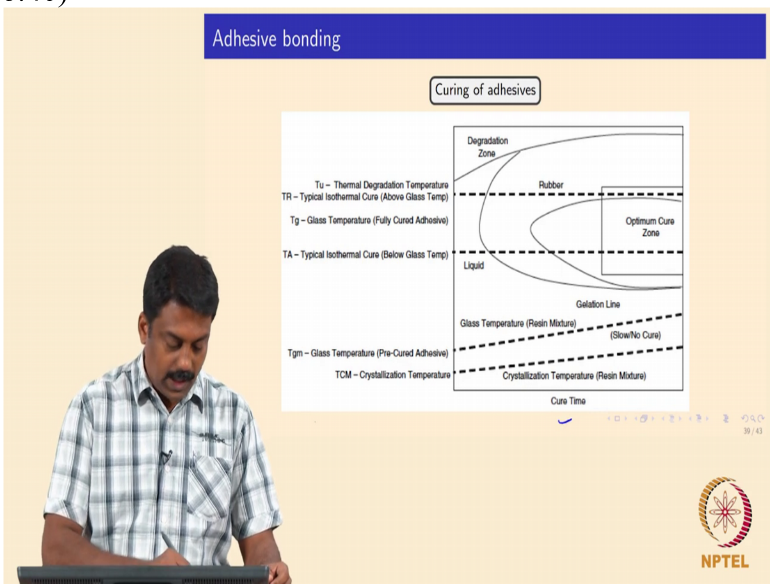

So in in all these processes, curing is achieved by heating above or by curing above the glass transition temperatures. Okay. So for example, this is the curing time and this is the characteristic of the various reactions that is possible in adhesive. Okay. For example crystalline and becoming glass transition and then you have melting. Okay. So generally, the curing is done above melting and then below the degradation temperature. Okay. So this is the optimum cure zone. Okay.

So ya if you go above degradation zone and then you are going to vaporise you are going you are going to burn your polymer, okay. So this is the glass transition line, gelation line. Then the curing is done. So in the temperature in the (())(7:29) of liquid and then below a degradation temperature. And the curing time can be reduced by applying pressure or by using in subsequent reactions like chemical reactions. You can also promote the curing right by chemical reaction as well.

Okay. Ya so it is one of the common commercial design. They need to work at room temperature because it has in a chemical reaction because of curing. Right? Because we cannot heat up all the time. Okay. So most of the commercial adhesives used for simple applications, household applications and they work at room temperature by chemical reaction. Okay. good.

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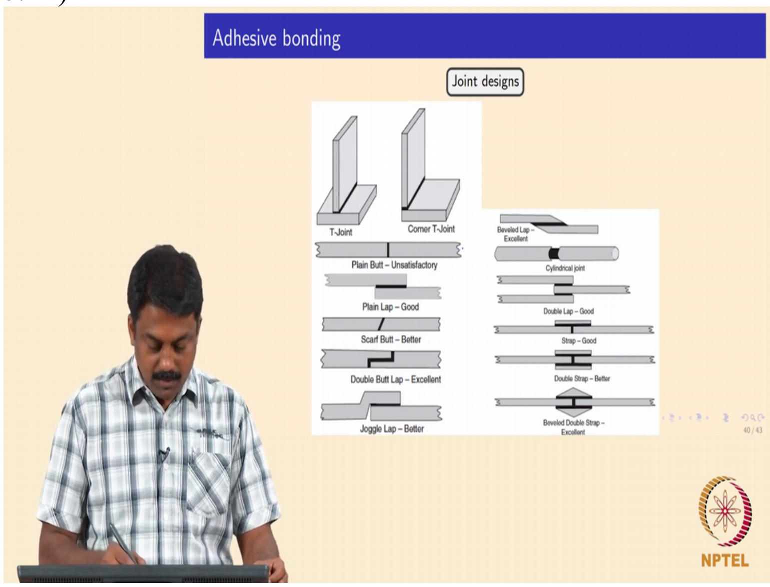

So joint designs, the most commonly used joint design is T joint or corner joint or you can also do, ya T joint, corner joint works perfectly. So when you have to do flat seat or rigid joining, you always have to do in overlap configuration. So you need to have in a proper lap distance and this is not advisable. Okay. Or you can also double butt lap, okay juggle lap. So generally adhesive bonding is not done in a plane butt. Or you can also do double lap in this consideration or in other way. And again, so this is also the commonly used double strap, okay beveled double strap. Right? So adhesive bonding is coming in a big way. Specially you know material, in alloys that are used now in automotive industries are becoming extremely complex in microstructures. So when you use diffusion welding process, you destroy the microstructure but the problem with the adhesive bonds is the weight.

You always add extra material, okay. So increase the weight. So unless we invent something you know which can work in a very small dimensions, you have I a very nanometre layer, micrometre layer of adhesive, it actually works the job then we can say okay. Otherwise, the weight gain you aim for, may not be achievable using adhesives. And adhesive joints are always poorer than in terms of mechanical properties much poorer than diffusion joints but in some of the applications where you do not need a good mechanical property or class performance, we can use that as bonds. Good.

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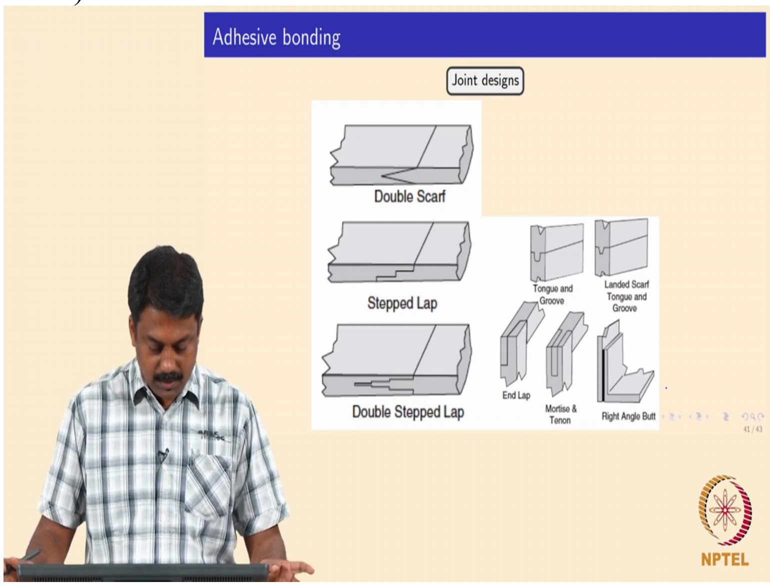

Some of the joint designs I gave. These are also commonly used for automotive applications. Double scarf, stepped lap, double stepped lap, tongue and groove and ya, right angle butt, you can just refer it from the slides.

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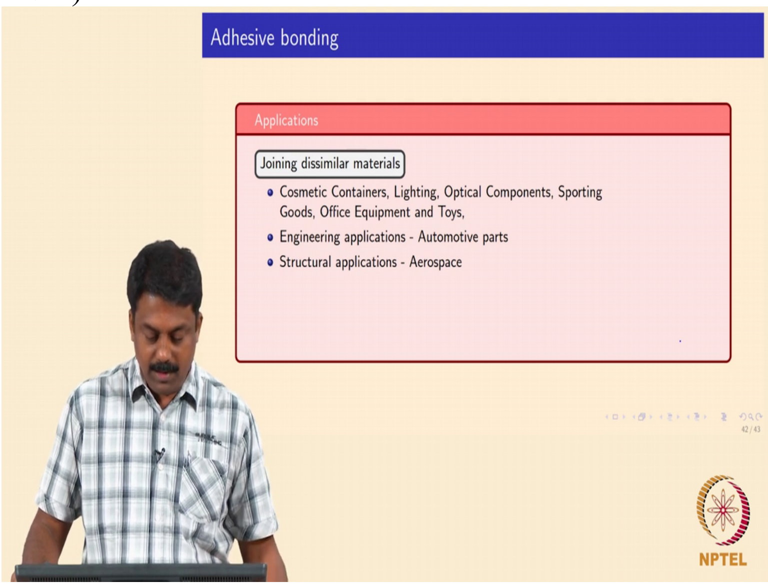

So what are the applications of adhesive bonding? In polymer specifics you know for cosmetic containers, lighting, optical components, sporting goods. Shoe. Shoe is a classic example. Is not it? Adhesive bonds. Office equipment, toys, automotive parts and aerospace applications are also very widely used to join dissimilar alloys. Okay. Adhesive bond.

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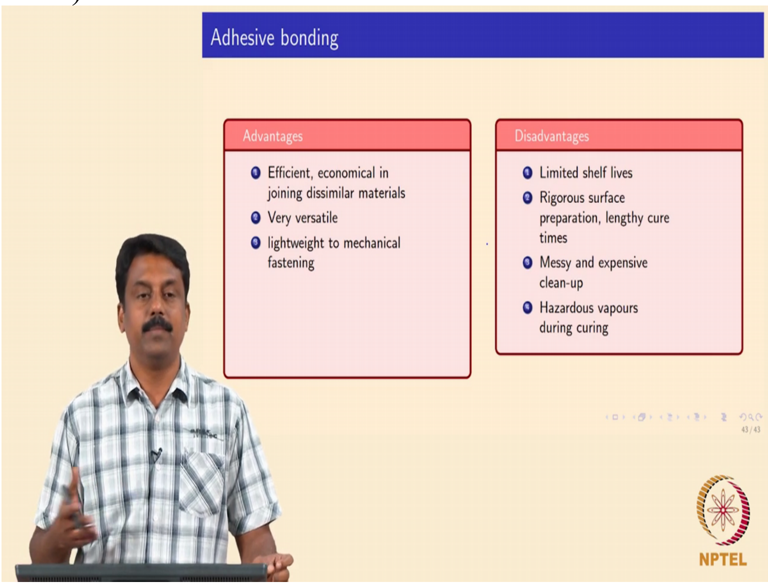

So advantages is the efficient, economical in joining or dissimilar materials. Very versatile. It is lighter than mechanical fastening. Okay. Disadvantage is the joint degrades over time. Right? So because the polymer degrades much faster than metals or alloys. And the surface preparation is extremely important. Okay. So if the surface preparation is not done properly, if the joints are done properly, you are not going to get good welds. It is extremely messy.

So we have adhesive bonding unit. You will have to use it only in a closed container because if you make a mess, you cannot clean it. okay. So it becomes extremely messy and expect that you need expensive cleanup. And it is also hazardous. So adhesive when they use, they are Caustogenic in most of the cases. So when you were curing, the vapour generated can affect, yes. Okay, good. So I think that is it. Any questions so far?

So what are the things we saw in this class? Lot of things, right? The principles of this process are very simple. Like you know if you look at hot plate, hot tool, right? The vibrations, the extrusion process, ultrasonic okay and then adhesive bonding. So these processes are commonly used for polymers. Right? So the principle we already discussed, for example, ultrasound using vibrations by friction. Adhesive bonding, you know mainly used for thermosetting polymers. Right? So we use 3 principles, absorptive, electrostatic or diffusing reactions to make joints using adhesives.

And based on the type of adhesive, we can classify them into like you know the physical form or chemical type by curing mechanism or with a function. Yes. So we will end up the processes.