Introduction to Materials Science and Engineering
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Lecture – 145
Toughening of glass: Ion-Exchange

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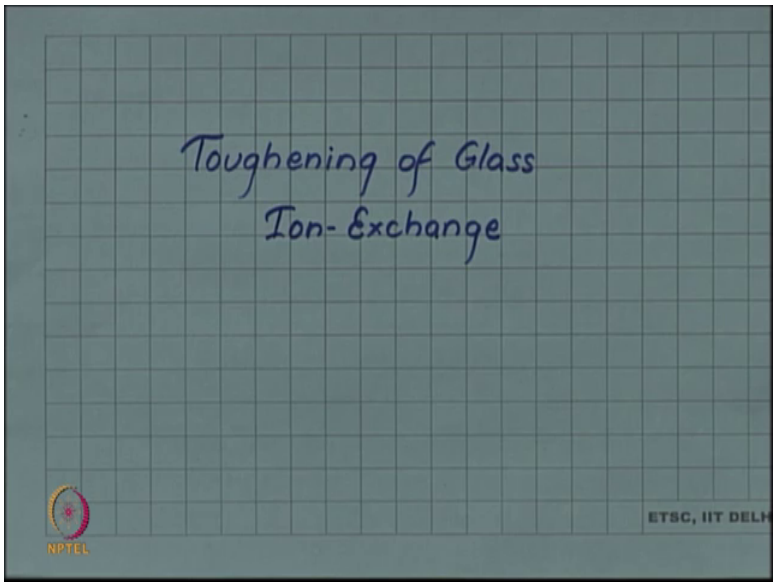

Let us consider Toughening of glass by Ion-Exchange.

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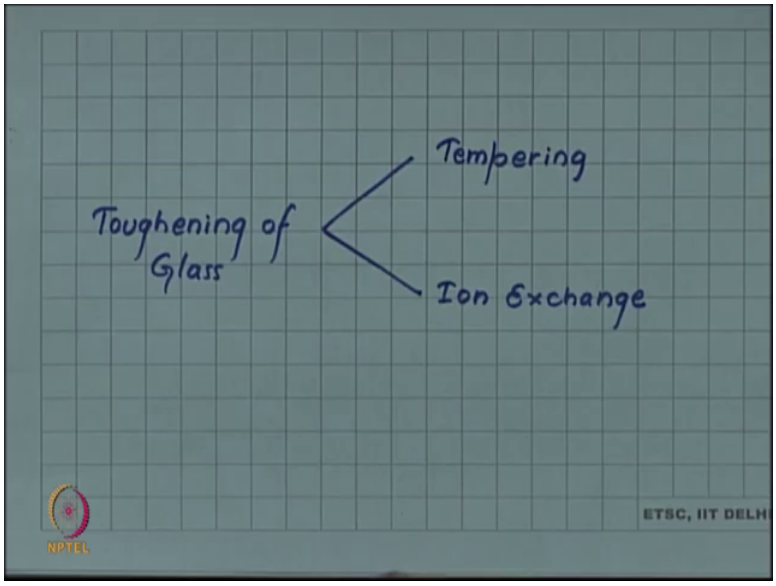

We have already considered the process of tempering which is a physical process for toughening of the glass; ion exchange is a chemical process.

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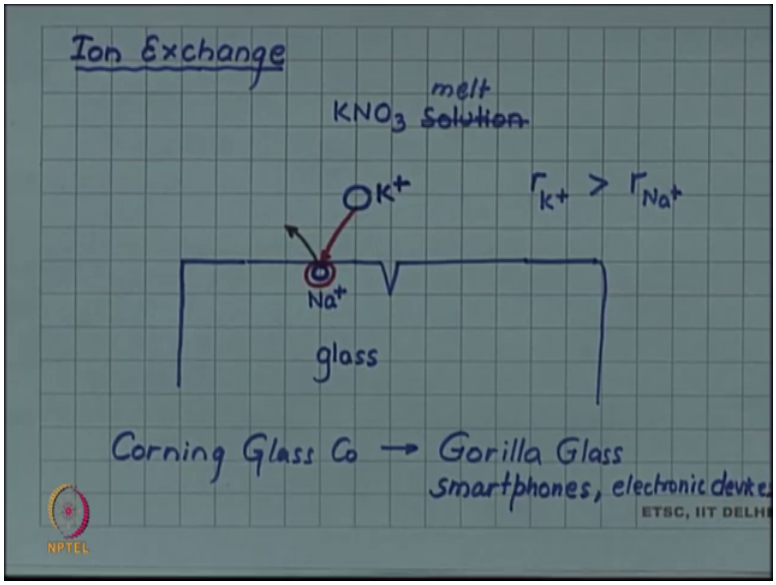

Here a glass surface; so, below this line below this line is glass and it is exposed to. So, let us say this is glass, it is exposed to KNO 3; not KNO 3 solution, but molten KNO 3, it is exposed to KNO 3 melt in which KNO 3 gives us potassium ion K plus ions. The glass is a soda lime glass and had sodium ions in the glass surface and the radius of potassium ion is larger than the radius of sodium ions.

However; chemically when this reaction takes place with the KNO 3, the sodium ions sodium ions go into the melt, whereas, potassium ions comes and replaces the sodium ion; that is why the name ion exchange. So, the sodium ion is replaced by the potassium ion, but since sodium ion was a smaller iron so, it left a smaller gap and that gap is now being filled by a larger potassium ion. So, in a smaller gap, you are filling a larger object. So, this leads to compressive strain in the region of the replacement. So, and since there are several such replacements along the surface because several sodium ions are being replaced by potassium ion, there will be an average compressive stress developing on the surface because of this exchange.

So, this method is particularly quite popular and one of the famous commercial success in this case is of corning glass of US, who have produced they call it by the brand name

Gorilla Glass; and this gorilla glass is used for all sorts of electronic devices; for example, Smartphone covers and other electronic devices.

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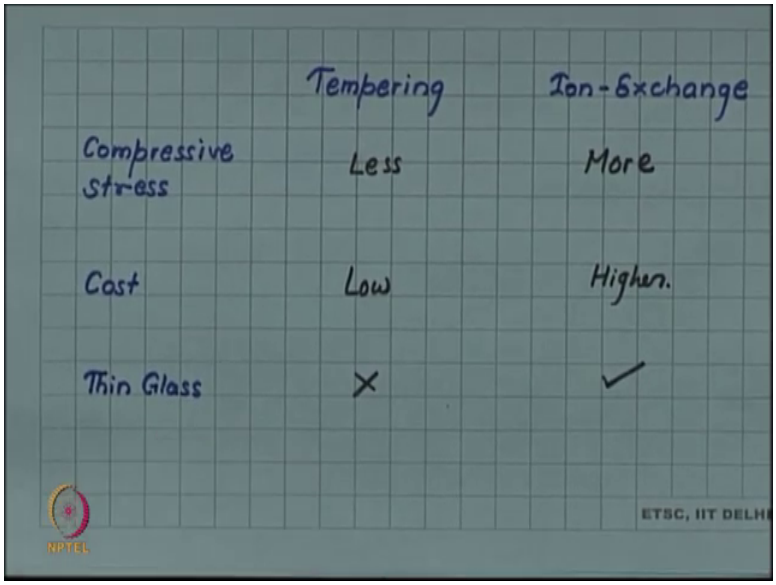

So, let us have a comparison between the two processes which we discussed, the tempering and ion exchange. The compressive stress developed in ion exchange method is more than in the tempering method, but the cost is also higher for ion exchange method.

And if the glass which it has to be toughened is very thin like the cover of smart phone, then that sort of thin glass cannot be handled by tempering cannot be toughened by tempering because you remember tempering involves heating and then by cooling with jets of air, this can lead to severe warping and thermal stresses in a thin glass plate. So, the shape can change, whereas, ion exchange method is a chemical method and is much more gentle from that point of view. So, thin glass can be handled by ion exchange, but not by tempering.