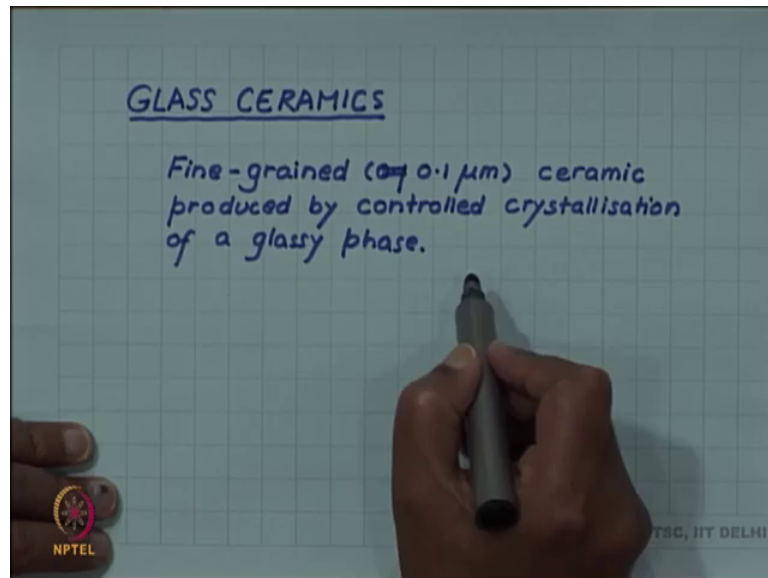


**Introduction to Materials Science and Engineering**  
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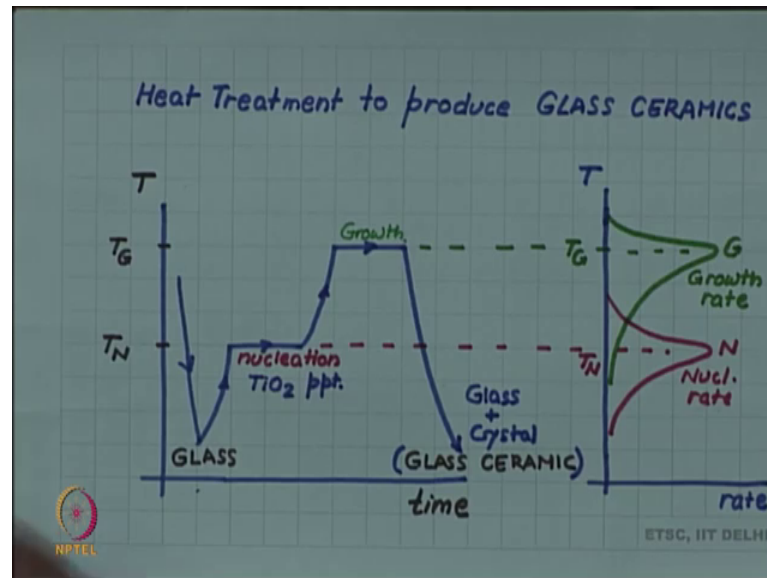
**Lecture – 105**  
**Glass Ceramics**

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Glass ceramic is an important class of ceramic material, which we will now look at. Glass ceramics are actually ceramic materials which are very fine grained; 0.1 micrometer in diameter is the grain size. And they are produced by controlled crystallization of a glassy phase, and that is why the name glass ceramic.

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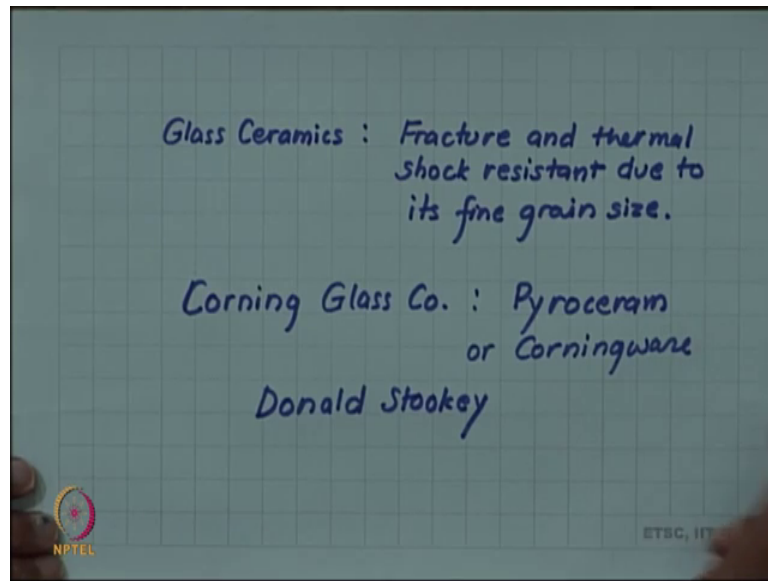


Let us look at the heat treatment process for glass ceramic. So, here is the temperature time the first figure is the temperature time figure, it shows the heat treatment cycle. So, initially the liquid is quenched to produce glass, then this glass is held at a temperature at which the nucleation rate is maximum. So, these curves recall we have a studied that, the growth rate and nucleation rate as a function of temperature show a maxima.

So, this N is the nucleation rate and G is the growth rate. So, at  $T_N$  this temperature  $T_N$ , the nucleation rate is maximum. So, several crystallites several crystal nuclei, form during this period this is a nucleation stage; however, if we continue at this temperature, the growth rate is very slow and the time required for formation of significant amount of crystal will be very large.

So, that is why a jump in temperature is given after a sufficient number of nuclei are formed, temperature is raised raised to a value  $T_G$ , which is the temperature at which the growth rate is maximum. So, thus whatever nuclei are formed at  $T_N$ , now they start growing at a faster rate finally, the material is quenched, to form the so-called glass ceramic in this glass ceramic. In fact, it is not fully crystalline it is actually glassy plus crystal. So, some glass matrix is also there one plus crystal, one should also know that during the nucleation stage, this for the growth stage and during the nucleation stage, some heterogeneous nuclei for example,  $TiO_2$  precipitate. And we have seen that heterogeneous nucleation is easier than homogeneous nucleation.

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So, these  $\text{TiO}_2$  precipitates form in the glass and they act as heterogeneous nucleation site, which further enhance the nucleation rate. The ceramic produced by this heat treatment, the glass ceramic is highly fracture resistant, glass ceramic fracture and thermal shock resistance.

And this is mainly due to its fine grain size, one of the commercial companies which first developed this kind of glass ceramics, and still is an important producer is the Corning Glass Company, who marketed it in the name Pyroceram or Corningware. The person responsible for this development was Donald Stookey and it is said that the discovery was accidental, in this he was doing some other experiment, where the glass got heated to a higher temperature and accidentally formed this glass ceramic.