

Windows and Glass

Question:

Which window of a car can tolerate the larger stress before breaking?

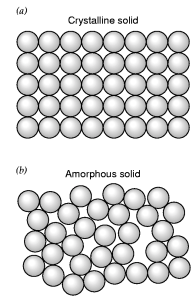
1. The front windshield
2. The side window
3. They're equally strong

Observations About Windows

- Windows are clear, but window glass looks greenish
- Window glass breaks if you heat it too rapidly
- Some older windows aren't very smooth
- Some car windows break into tiny pieces
- Window glass can be bent if you heat it carefully

Glasses

- Amorphous solids
- No crystal structure
- No long-range order
- Resemble “frozen liquids”

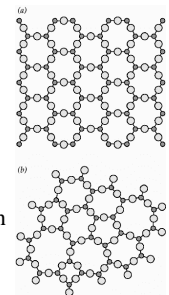


Forming a Glass

- Requirements
 - Material must have high viscosity at melting point
 - Material must have difficulty nucleating crystal
- Procedure
 - Melt material to eliminate crystal structure
 - Cool material quickly through melting temperature
 - Form supercooled liquid
 - Cool until solid

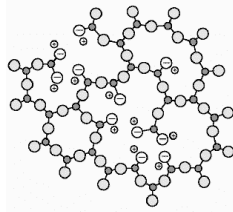
Quartz

- Quartz is silicon dioxide (silica)
- Is an excellent network former
 - Slow cooling forms regular network
 - Fast cooling forms irregular network
- High viscosity at melting point
- However, nucleates crystals easily
- Melting point of Quartz is very high



Soda-Lime-Silica Glass

- Adding sodium oxide (soda) lowers melting point
- Adding calcium oxide (lime) makes it insoluble
- Sodium and calcium ions terminate the network and soften the glass
- Soda-lime-silica glass is common glass



Borosilicate Glass

- Soda-lime-silica glass expands much when heated
 - Breaks easily during heating or cooling
- Boron-oxide-silica glass expands less
 - Tolerates heating or cooling reasonably well
- Pyrex and Kimax are borosilicate glasses

Tempered Glass

- Tempering glass
 - Heat glass to softening point
 - Cool outside of glass quickly
 - Outside stiffens while inside is still hot
 - Shrinking inside compresses outside
 - Compressed outside stretches inside
- Resists fractures because surface is compressed
- Crumbles when cracked because inside is tense

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