CORNING

The Science Behind Glass

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Science & Technology

Overview

- What is glass?
- Unique features of glass
  - Chemical durability
  - Thermal behavior
  - Electrical

Practical Definition for Commercial Glass

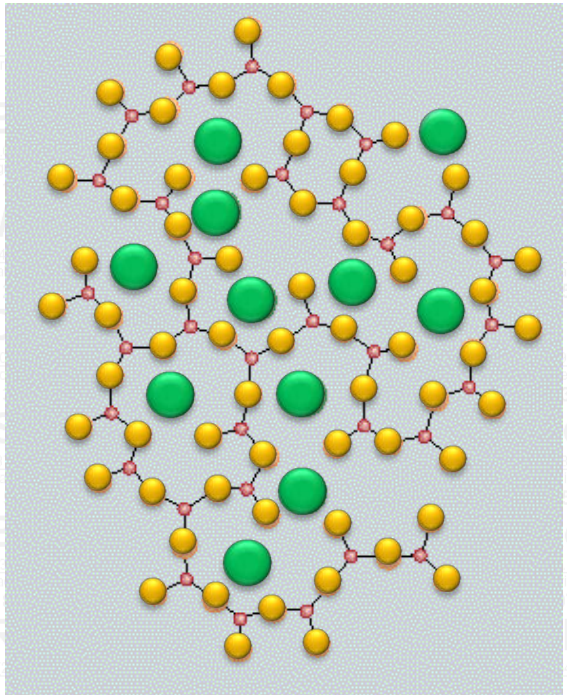
glass (glăs)

n.

1. *Inorganic transparent material*
2. *Hard, brittle, mechanical solid with modest strength (70MPa) in bulk form at room temp.*
3. *Chemically durable, dielectric*

Many types of silicate glasses…

The commercial glass chemist's periodic table



5	8
B	O
13	14
Al	Si

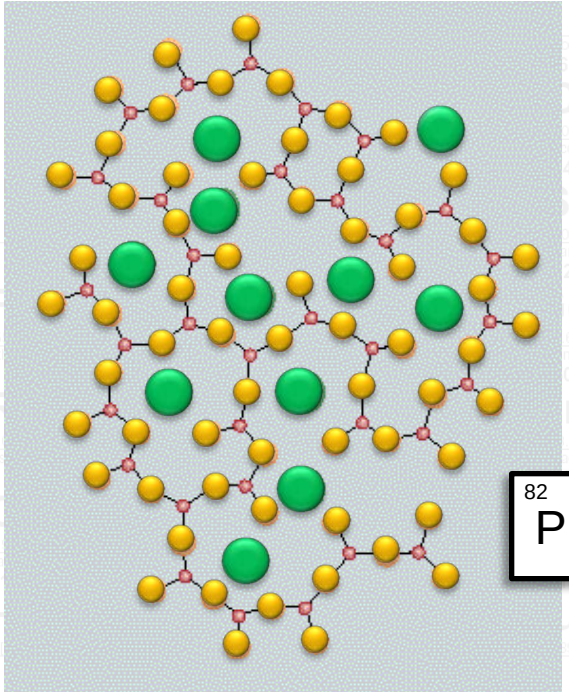
Glass formers
(make a stable glass network)

Many types of silicate glasses…

The commercial glass chemist's periodic table

3 Li	4 Be
11 Na	12 Mg
19 K	20 Ca
37 Rb	38 Sr
55 Cs	56 Ba
87 Fr	88 Ra

Network Modifiers
(promote melting – fluxes
Impart durability - stabilizers



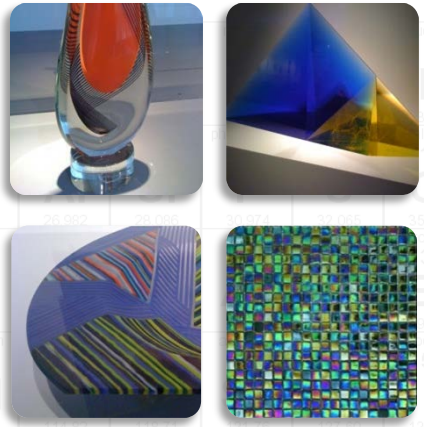
82 Pb

Many types of silicate glasses…

The commercial glass chemist's periodic table

Colors and contaminants

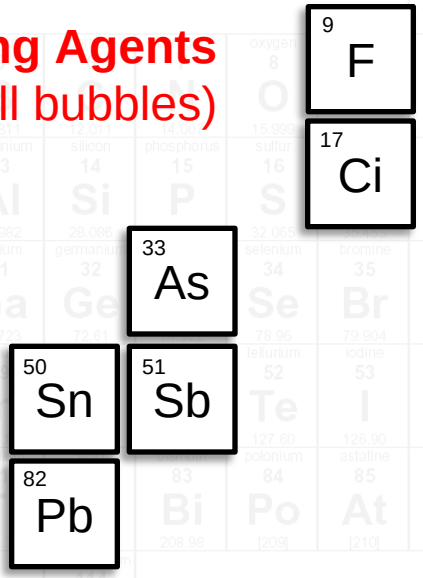
23	24	25	26	27	28
V	Cr	Mn	Fe	Co	Ni



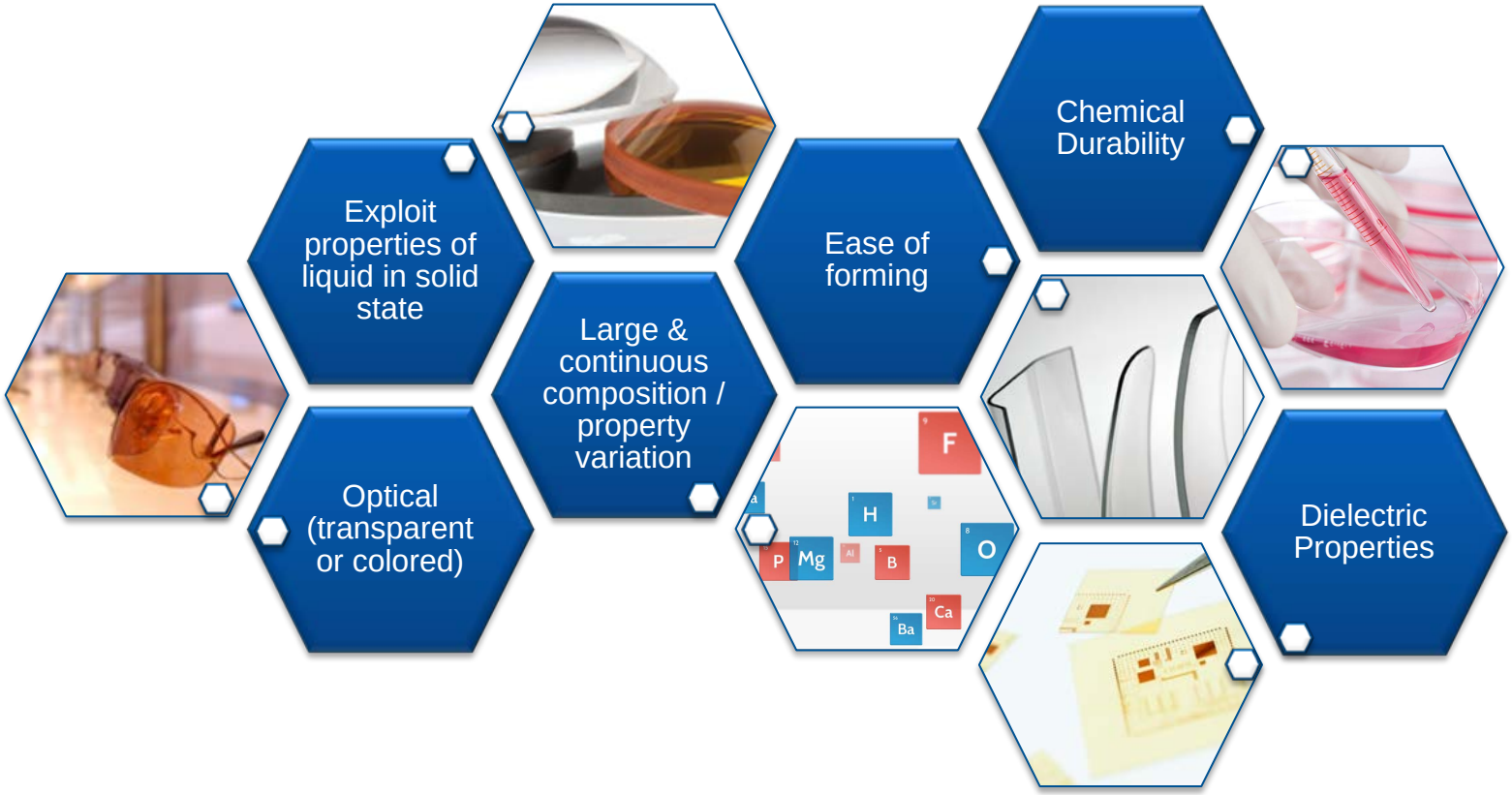
Many types of silicate glasses…

The commercial glass chemist's periodic table

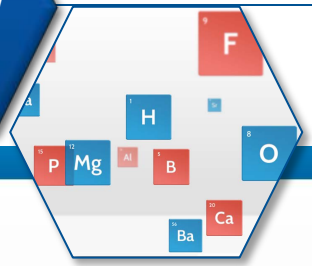
Fining Agents
(remove small bubbles)



Uniqueness of Glass



Large & continuous composition / property variation



- Glass is a good solvent
- Tailor-made properties (CTE)

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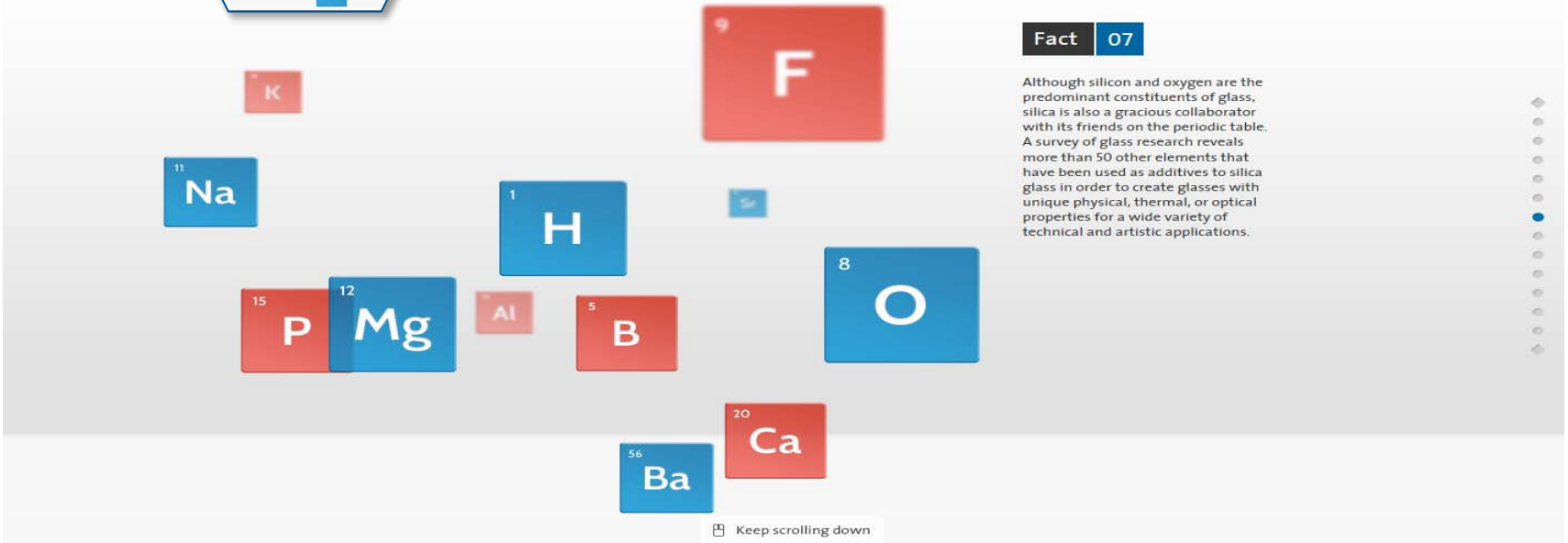
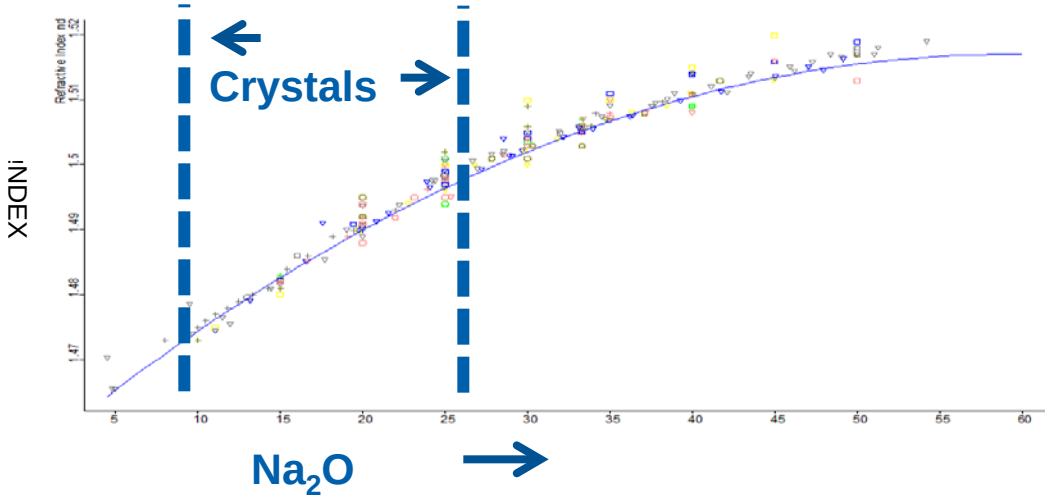


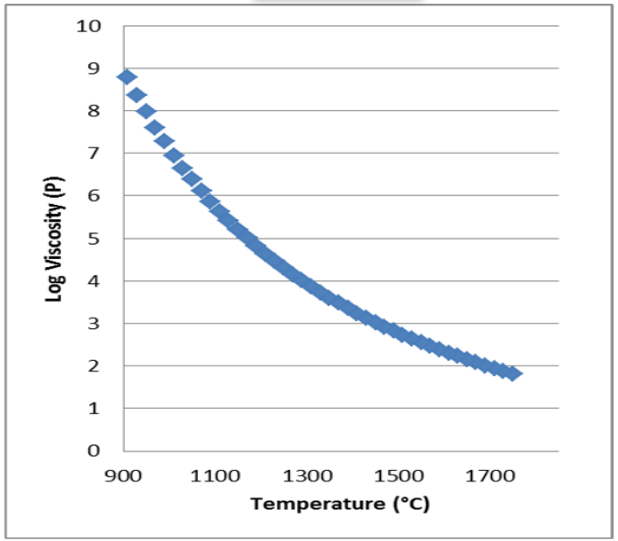
Exploit properties of liquid in solid state

- Phase separation
- Crystallization
- Glass-Ceramics

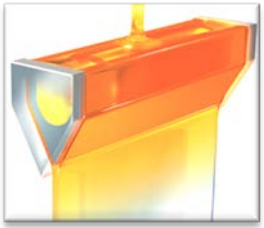
- Continuous property variation in glass
- Tailor made index



Ease of forming



- Viscosity varies smoothly and continuously with temperature

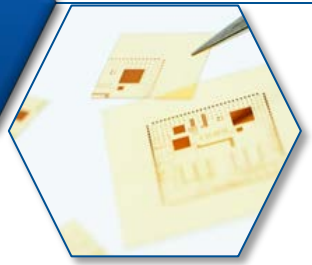
Rods, fibers, canes	Sheets	Forms
		
• Tube making • Fiber draw	• Fusion draw • Float process • Rolling or stamping	• Glass blowing, lamp-working • Ribbon machine • Bottle machine

Chemical Durability

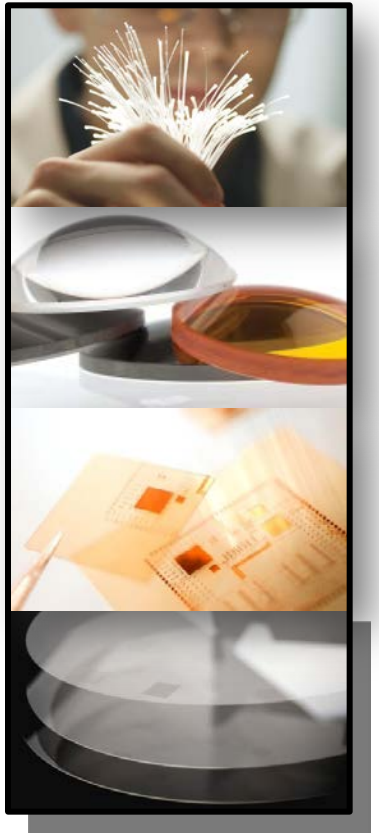
Chemical durability depends on composition

- Acids & mild bases
- Water, atmosphere (CO_2)
- Commercial glasses resistant to solvents

Dielectric Properties



- Can have low dielectric constant
- Low loss tangents



Summary

- Commercial Glasses: mainly silicate based, but much compositional variety
- Glass is a good inorganic solvent
  - Can have many elements / oxides plus SiO_2 (silica)
- Glass has continuous variation of properties with composition
  - Can tailor properties like CTE, Index, Density, Electrical
  - Smooth viscosity change with temperature allows many types of forming processes for technical products and artwork
- Glasses can be chemically & mechanically durable

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