

Glass Products for the Future:

An academic's perhaps naïve, but an out-of-the-box perspective

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Challenge for the future: **Plastics**

Polymers vs. glasses

- Less brittle, more flexible
- Faster response to external fields
 - A matter of T_g – Get it down!
- Superior formability
- Lower cost
- Less stable

⇒ One short term solution: polymer-glass hybrid materials



Glass: conventional vs. cutting edge

Conventional:

- Consumer products – windows, insulation, glassware
- Based on well established technology
- Huge volume
- Some evolutionary improvement in products
- Cost/unit is the main consideration
 - Energy efficient technology
 - Cheaper raw material
 - Cheaper labor costs



- Shift to ‘manufacturing advantaged countries’



Lesson from steel industry...



Late 1980's

~ 15 years



Early 2000's

Bethlehem Steel

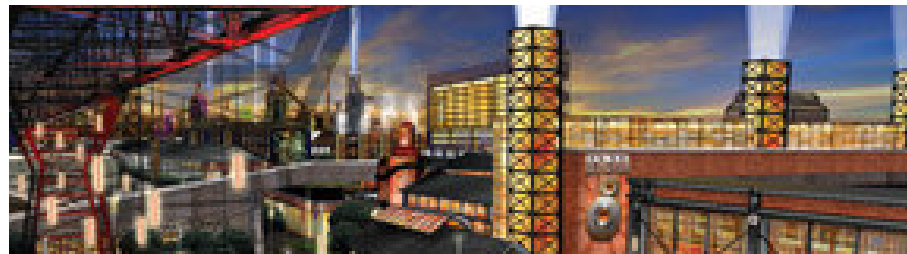


Possible backlash?

June 22, 2007, Morning Call front page news:

It 'used to be that if a developer was erecting a tall building, the innovative rolling mill in Bethlehem was the only place to get steel beams strong enough.

..it comes with a sobering dose of irony that the biggest hurdle facing Sands BethWorks is getting steel beams to the site that was once the worldwide epicenter of structural steel.



Cutting edge glass: brighter and sharper, however....

- Low tonnage, value added products
- Complex compositions
- Novel, highly sophisticated processing
- ↓
- The ultimate product is much more than glass
- Different business model than for conventional glass
- Requires significant, active R&D on a continuous basis

New game, possibly new players:

- IBM, Macronix, and Qimond (also Samsung..): ubiquitous chalcogenide glass film based flash memory to be replaced by the new-and-improved "phase-change" memory. .. it's supposedly 500 to 1,000 times faster than conventional flash memory and uses about half as much power to boot.
- DuPont Drylox Cover Glass- a high-capacity getter to rapidly and reliably capture contaminants that diffuse through the seal area.



Cutting edge: brighter and sharper

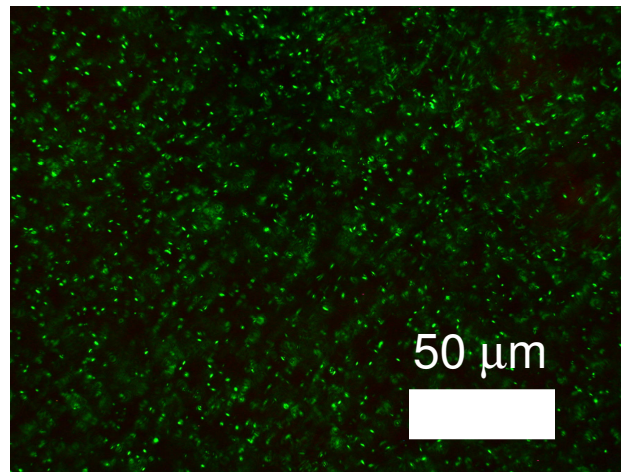
If glass can meet the challenge from polymers!

- Crystallization of glass is easier than that of polymers.
- Inorganic crystal phases can have uncommon active properties like ferroelectric, ferroelastic, .. (Liquid crystals may provide some competition).

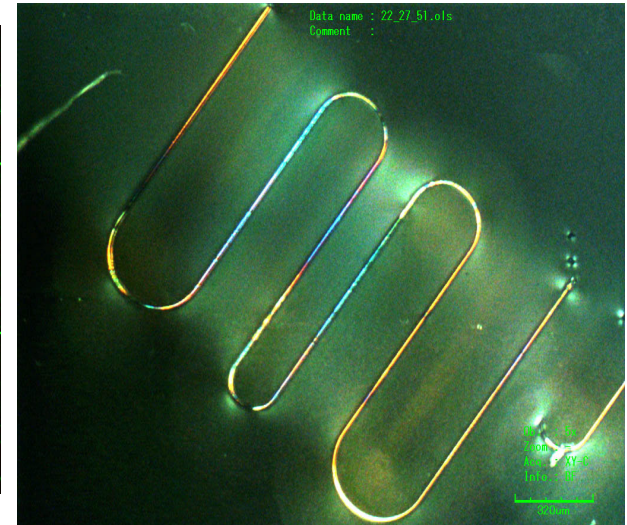


Active glass-ceramics

Transparent glass nano-composites or refractive index matched micro-composites



LBGO 9hrs
nucleation



Non-oxide systems:

For example, chalcogenide glasses: Unique properties

- IR optics
- High refractive index
- Phase change optical and electrical memories
- Photosensitivity: photoresists for micro/nano lithography
- .
- .
- .



Int'l Workshop on Scientific Challenges of New Functionality in Glass

(a) Electrical functionality and (b) nanostructuring of glass

Industry Leaders:

<i>Item No.</i>	<i>Rank</i>	<i>Area</i>
1	1	Lead-free, heavy-element-free glass
2	1	Low melting glasses without boron or lead
3	2	New functionalities of glass via engineered nano/macro porosity
4	2	Micro/nanopatterning and Lithography

Researchers

1	1	Interfaces in electronic glasses
2	1	Micro/nanopatterning and Lithography
3	2	New functionalities of glass via engineered nano/macro porosity
4	3	"Fatigue and re-writability of chalcogenide glasses for phase change memory"



Necessity to collaborate....

Ardent Bement, NSF Director

Harvard Business School sociologist **Dr. Kantor** identified collaborative advantage as a key strategy in a highly competitive environment.

"In the global economy a well-developed ability to create and sustain fruitful collaborations gives companies a significant competitive leg up."

Three fundamental aspects of successful business alliances:

1. Although most alliances provide benefits for the partners, successful ones also provide an "option on the future, opening new doors and unforeseen opportunities."
2. Legitimate collaboration involves creating new value together, in contrast to a tit-for-tat exchange of value that already exists.
3. Successful alliances do not flourish within "command and control" systems; they require a rich environment of interpersonal links that enhance learning.

It may seem paradoxical that collaborating more with competitors is a winning strategy. . . .
... fruitful collaboration produces benefits that flow to all the parties that cannot be obtained by any of them separately. It strengthens understanding across disciplines... it lays the foundation for as yet unknown opportunities for further collaboration.

❖ **Among glass researchers**

❖ **Between glass and other specialists**

❖ **Across the national and company boundaries**

