



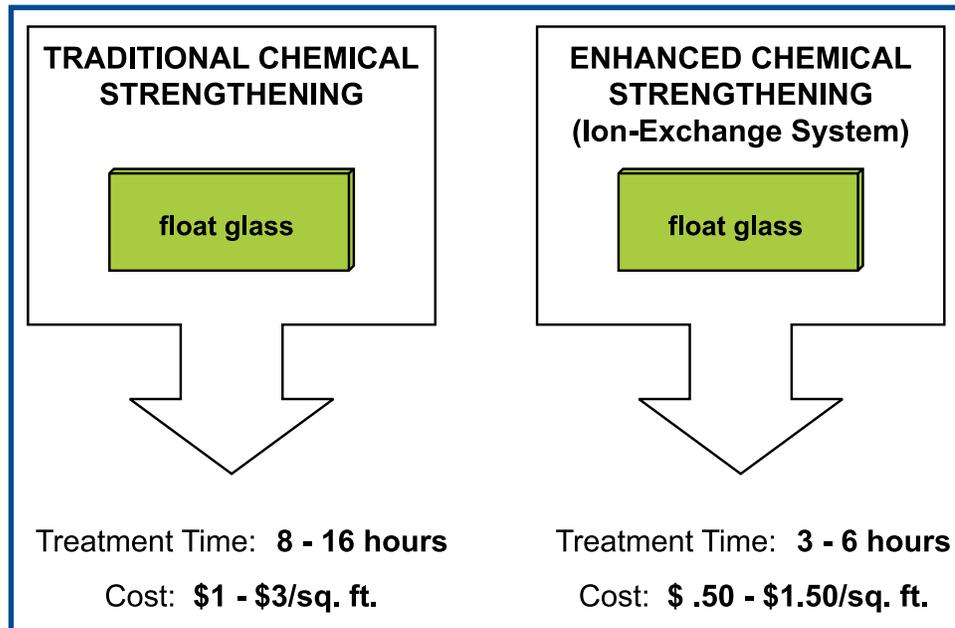
## INDUSTRIAL TECHNOLOGIES PROGRAM

# Integrated Ion-Exchange Systems for High-Strength Glass Products

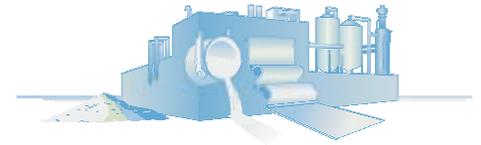
## Increasing Ion-exchange Rates Would Yield Stronger, More Cost-effective Products

While chemically strengthened glass has better optical properties and is stronger than conventional, thermally tempered glass, it requires a lengthy treatment time that often makes it an uneconomical and inefficient option for manufacturers. Project partners planned to research several innovative systems using ion exchange, a process which substitutes one chemical ion for another, decreasing

strengthening time. This shortened treatment time would make chemical strengthening a more commercially viable and cost-effective option for glass manufacturers. Researchers planned to experiment with mixed alkali compositions that have higher exchange rates and with nonisothermal exchange processing, in which gradual glass bath temperature reduction increases the exchange rate.



*Shortened treatment time for chemically strengthened glass will translate into direct cost savings.*



### Benefits for Our Industry and Our Nation

- Lighter, stronger glass products that will allow the industry to compete with alternative materials, particularly plastics
- Increased energy efficiency—reducing glass mass in a container or float product by 25 percent could reduce the required energy more than 1MM Btu/ton of glass produced
- Reduced costs and improved efficiency of the strengthening process due to shortened treatment time
- New market opportunities, including development of new and safer products

### Applications in Our Nation's Industry

The ion-exchange process can be applied in various industry segments. Thinner automotive glass manufactured using this ion-exchange process could save 0.1 BBL/yr in gasoline/car due to better gas mileage. Similarly, lightweight containers could reduce industry transportation costs—one wine company estimates that it could save \$500,000/yr for each ounce reduction in champagne bottle weight.

## Project Description

**Goal:** Develop a commercially viable, integrated, ion-exchange system for soda-lime-based compositions that reduces strengthening times by a factor of two to five.

In addition to mixed alkali glass compositions and nonisothermal processing, researchers will also examine ultrasonic assisted exchange, a process of applying ultrasonic energy waves to the glass during ion exchange. While not yet well understood, ultrasonic assisted exchange may be able to increase exchange rates by up to a factor of two.

## Progress and Milestones

- Over 25 experimental glasses were melted and exchange depths determined.
- Mathematical modeling was conducted for predicting depth vs. composition.
- Durability of 15 commercial and experimental glasses was determined.
- Hardness and toughness measurements were completed for several commercial compositions.
- Several potential compositions identified which satisfied strength, durability, and melt temperature requirements.
- This project was terminated in 2001 when the principal investigator was unable to continue work on the project and a suitable replacement could not be found.

## Project Partners

AFG Industries  
Kingsport, TN

Canandaigua Wine Company  
Canandaigua, NY

Center for Glass Research  
Alfred, NY

Libbey Inc.  
Toledo, OH

Saxon Glass Technologies  
Alfred, NY

TransResources  
New York, NY

Viracon  
Owatonna, MN

Visteon Glass Systems  
Dearborn, MI

Vitro Corp.  
Monterrey, Mexico

## For additional information, please contact

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## A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



**U.S. Department of Energy**  
**Energy Efficiency and Renewable Energy**  
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

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