Notes from Glass Strength Symposium – Friday June 5th Wrap-up Session

A group of 15-20 attendees met from 8 to 11 am on June 5th to discuss the symposium on Thursday June 4th and to plan next steps. The candid, facilitated session included positive and negative impressions of the glass strength symposium and recommendations for improvement. Each attendee at the Friday session was offered an opportunity to comment on Thursday's meeting. In general the attendees were very impressed and pleased with the attendance at the meeting on June 4th and with the level of participation. There was a general consensus that more time was needed for a deeper discussion and that a one day meeting was too short for the scope of this topic. The diversity of the attendees was cited as a positive factor with the mix of representatives from academia, industry and the glass user community. There was a feeling that several of the speakers could have broadened the scope of their talks and included not only their own research efforts, but also research others are doing in their individual fields of interest and expertise. All the individual comments were documented and will be available to the core group charged with planning and developing future sessions on glass strength.

The attendees were also asked to share their general impressions about how to move forward in glass strength and to recommend the highest priority collaborative initiatives that should be pursued as next steps to best improve glass strength. Below are the action items that were agreed to by the group:

General Impressions about How to Move Forward in Glass Strength

There were several suggestions about how and when to convene a next meeting on this topic including recommendations for improvement in the meeting structure and preparations. There was a general consensus there should be some follow-up meeting to this symposium. Several attendees recommended a "stand-alone" focused follow-up meeting to build on the talks and discussion initiated in this meeting.

There was considerable enthusiasm for a longer meeting like the 1983 NATO sponsored gathering convened by Chuck Kurkjain. A two to three day follow-up conference modeled after the Gordon Research conferences was also mentioned as a possible format. It was recommended that a "core group" be commissioned to plan the next meeting. The GOMD meeting in May 2010 was suggested as one possible date for a next meeting. The GMIC meeting in October 2009, an ICG meeting in November, and a June 2010 Fractography conference were mentioned as other possibilities for a follow-up session. It

was suggested that the speakers for the next meeting be asked to structure their presentations to be broader in scope and that members of the core planning group meet with the speakers one-on-one to help shape their presentations.

A key general follow-up recommendation was that GMIC should package this output from this symposium and pursue buy-in and funding for research work on glass surfaces. One participant presented the following succinct statement of the problem and goal for the work needed and suggested five research paths:

Problem/Goal Statement: Better understand the glass surface and how to better protect it across all the multiple product lines.

Research Paths:

(1) Fundamental material understanding including a fundamental understanding of how molecules interact with the glass surface.

(2) Modeling

(3) Development of new coatings to protect the surface (platform solutions)

(4) Development of better surface treatments

(5) Improve handling of glass products to minimize contact damage (engineering solutions)

A strong multiple company and university collaborative effort will be required to achieve a significant improvement in glass strength. Government funding will also be needed to support a robust research program in glass surface improvement.

Three Highest Priority Collaborative Initiatives

I. Goal: Improve the usable strength of as-manufactured glass products by 3 to 5 times.

What needs to be accomplished? A higher percentage of the intrinsic strength of glass produced needs to be preserved through coatings on the glass and by developing a comprehensive understanding of how the glass surface interacts chemically and mechanically with its environment. A more through understanding of the interaction of the as-manufactured bare and coated glass surface will aid the development of novel coatings and coating techniques that can be tailored to particular segments of the industry and to specific product forms.

This program should include both mathematical modeling and experiments on as manufactured glass to better bridge between the existing laboratory

experiments and the manufacturing process environment. Equipment manufacturers and manufacturing experts should be engaged in the design of experiments that better mimic the manufacturing environment. Goals will be defined for this program 1) to attract industry support, 2) verify that the work is proceeding at a satisfactory rate and in the right direction, and 3) early economic benefits can be identified and realized.

Who should be involved? A diverse research team is needed, including coating experts, surface modeling experts, experts in fracture mechanics and contact damage and glass composition experts. A seasoned program manger will be needed to structure and manage the program. Ideally, the program should be International in scope. GMIC will take the lead in an attempt to obtain industry input on this program and develop broad based industry and government support for this research initiative including most likely sources of funding.

When? To maintain the momentum generated at the symposium, a presentation of the proposed research program should be developed by a small working group with-in a month. The presentation should be given to companies in the glass industry and to selected government agencies over the next several months. A short term objective is a well defined and funded research program that could be presented to a broad industry audience and launched at the GOMD meeting in May 2010.

II. Goal: Continue the momentum of interest in glass strength generated at this symposium and provide a forum for continuing an on-going dialogue.

What? Convene a summit conference on glass strength that is similar to the Gordon Research Conference or the 1983 NATO sponsored meeting referenced earlier. This longer meeting will provide the opportunity for a deeper discussion of many of the issues raised at the symposium.

Who? Include attendees that have a broader perspective on the issues and opportunities in improving glass strength. Include glass users, e.g., architects, specifiers, container users, solar energy companies, etc. Consider having breakout sessions that discuss specific topics or specific industry segments issues. Several organizations that could be involved in developing the program include IMI, GMIC, ICG, ASTM.

When? Discussion of his initiative will be included in the agenda of the GMIC Board meeting scheduled for September 15-17 at IMI in State College, PA. This board meeting will also include a discussion of the several RDAC research proposals that include glass strength. The proposed summit conference on glass strength could be convened as an extension to an already

scheduled meeting such as the Glass Problems Conference, the GOMD meeting or another future ACerS meeting.

III. Goal: Develop a comprehensive glass strength database including glass strength mechanical properties and results from the non-destructive evaluation of glass materials.

What? Create a glass strength database with a screening and evaluation procedure to increase the confidence in the data included. Solicit industry cooperation and provide for anonymity by establishing an independent non-competitive third party clearing agency. This initiative could include the data generated from the "improve usable glass strength initiative" discussed above. The database could also include strength audits similar to energy audits from furnaces conducted across the glass industry. The glass container industry is the most likely early beneficiary of data collection and analysis.

Who? The glass industry would share mechanical property data, including data on the "low strength tails". Glass fiber and optical fiber producers have collected and analyzed some data on flaws and have initiated individual company programs. The glass container industry could benefit from the lessons learned in these other segments if individuals from these segments serve as consultants to a database program focused on fractography for the container industry. Owens Illinois, Longhorn Glass, and Gallo were mentioned as several companies that could collaborate on this initiative. A large glass container user like Coca-Cola could also be a participant in this collaborative program.

Experts in fracture mechanics and in the container forming and handling process are needed for this program as well as the cross segment experts referenced above.

When? An assessment of the progress on database development by other organizations such as, ACerS, ICG (TC6), NSF and SCIGLASS is needed to help determine the benefit of an extended, more comprehensive and technically reviewed database. As a first step, GMIC will gauge the interest of the container industry in leading this collaborative effort.