



GMIC STRENGTH STEERING TEAM AND CORE RESEARCH TEAM

TO: Strength Steering Committee and Core Research Team (see Appendix A)
CC: May 20, 2010 GMIC/DOE Strength Workshop Participants
FROM: Louis Mattos, Jr. (SST Chair), Charlie Brossia (SST Vice Chair)
SUBJECT: Strength Research Coalition Structure

Goal of May 20th meeting: Propose a research coalition structure through the SST Strawman and CRT Abstracts. Reach consensus on the structure and identify industry champions to solicit industry commitment/funding.

Glass Strength Research Coalition:

- 1) **Objective:** To develop a pre-competitive research program to identify critical parameters for improving the usable strength of glass.
 - a. While research into the strength (and weakness) of oxide glasses has been the subject of interest in both the glass and fracture mechanics communities for many years, very little improvement in the practical, useful strength of these materials has been realized. This proposal is based on the premise this is an appropriate time to revisit this problem.
- 2) **Proposed Structure:**
 - a. **Overview:** The proposed structure is based on the premise glass companies cannot independently support a fundamental research agenda to understand and significantly improve the usable strength of glass. However by working together with pooled funding and shared risk, the opportunity to significantly improve the usable strength of glass is achievable. The proposed coalition will initially focus on "*precompetitive research*" with two (2) overarching outputs to benefit coalition members.
 - i. A fundamental understanding of the initiation of flaws in both simple and multi-component oxide glasses.
 - ii. The development of the next generation of glass technical experts and researchers.
 - b. **Proposed Initial Research:** Initiate a major study on the nucleation of flaws in simple and multi-component oxide glasses resulting from mechanical contact. The research philosophy has been outlined by the Core Research Team in the white paper titled: "ON IMPROVING THE PRACTICAL STRENGTH OF GLASS: Studies on the generation and reduction of strength-impairing flaws in glass. Making oxide glasses more robust!"
 - i. Investigate surface and subsurface damage, and the loading conditions which lead to such damage, under both sharp and blunt contact.
 1. A variety of advanced analytical tools will be used: strength testing, stress birefringence, atomic-force microscopy, Raman spectroscopy, optical microscopy, etc.
 2. A variety of atomic level, molecular modeling tools will be used.

3. Of particular significance will be use of the *CRI-Inc, Abrio Instrument* measuring stress birefringence used to calculate the distribution of stress when damage is initiated.
- ii. Investigate the effect of surface chemistry and coatings on the nucleation of flaws in multi-component oxide glasses. The impact of near surface phenomena including friction, residual stresses, corrosion and surface coatings will be evaluated. Finite Element analysis will be used where appropriate.
- iii. The study shall include alkali and non-alkali glasses primarily composed of mixtures of the following elements: Si, Al, B, alkali, alkaline earth. The compositions of interest will be determined by mutual agreement of the Research Coalition. All glass will be supplied from a single batch, prepared by a commercial glass melting company with a defined surface condition. The impact of both glass composition and thermal-history induced structural changes on initiation of flaws will be studied.
- c. **Education:** The benefit of an Industry-University consortium is to expose the graduate students to industry mentors throughout the project lifetime. Research projects will be designed so as to support the development of graduate students who, upon completion of projects and studies, will find highly desirable employment opportunities in industry allowing them to continue their work aimed at taking their knowledge and experience to commercial application.
- d. **Path Forward:** Develop the technology roadmap that will build consensus for an international coalition of industry and university members.
 - i. Obtain glass company commitment to support six-month initiative to identify the pre-competitive research technology map, the structure for proposing research programs and the structure for managing research programs and funding. Concept is based on similar initiatives (ie Submerged Combustion Melter – SCM).
 1. Industry to assign responsible individual to leadership team
 2. Industry to commit seed funds to support structure building phase
 - a. Est: \$50,000 budget; split among participating members
 - ii. Commence meeting of international glass researchers to develop technology map.
 1. Researcher travel to be covered through coalition seed funds.
- e. **Membership:** The proposed membership model is focused on the building of a strong core of industry partners committed to the development of stronger usable glass. Candidate structures for the coalition to move forward are listed below. The final working structure will be determined by the membership of the glass strength coalition “seed funding” team, outlined in section 2d.
 - i. “*Research funding pool*” will be leveraged to solicit matching funds from United States government agencies.
 - ii. NSF Industry University Center
 - iii. Additional Alternative Structure
- f. **Research Funding Assumptions for Research Funding Pool:** The following section outlines a theoretical funding structure for the Research Funding Pool Structure identified in section 4d. Funding structures will be discussed in more detail by the “seed funding” team, outlined in section 2d.
 - i. **Research Funding Assumptions:**
 1. Ten (10) sub-projects: total required funding is \$2.75 M for five years
 - a. five (5) PhD: 4 yrs at \$93,750 /yr (each)
 - b. five (5) MS: 2 yrs at \$87,500 /yr (each)
 2. Matching funding rate: 20% from Coalition and 80% from Agency
 - ii. **Member Obligations**
 1. 5 year commitment from industry partners
 - a. Members will provide a representative to serve on the Coalition Board.
 2. Target: minimum of five (5) core members.
 - a. Minimum one (1) member from each of the four (4) primary glass sectors: container, fiber, flat, specialty

Assumptions:	PhD student	4	years at	\$93,750	/year
	MS student	2	years at	\$87,500	/year

Coalition Match Rate	Students/Projects		Total \$ (5 yrs)	Members		
	PhD	MS		#	\$/yr	\$/5 yr
20%	5	5	\$2,750,000	5	\$22,000	\$110,000
	5	5	\$2,750,000	6	\$18,333	\$91,667
	5	5	\$2,750,000	7	\$15,714	\$78,571
	5	5	\$2,750,000	8	\$13,750	\$68,750
	5	5	\$2,750,000	9	\$12,222	\$61,111
	5	5	\$2,750,000	10	\$11,000	\$55,000

- iii. **Intellectual Property:** The *precompetitive* nature of the coalition structure implies the goal is not to generate proprietary Intellectual Property. Individual companies will use the precompetitive output of the research to conduct independent competitive research/development and create intellectual property in their field of use.
 - 1. Individual researchers will publish research in refereed journals.
 - 2. At the completion of the research program, the CRT board will draft a comprehensive report “*synthesizing*” the findings of all projects conducted under the Coalition. The report will recommend a path forward for Coalition members to increase the usable strength of commercial glass products.
 - a. The synthesized report will not be published. The distribution of the report will be limited to Coalition members.
 - 3. University partners will file IP based on research outputs at their university.
 - a. Universities will grant royalty free access to Coalition members. Conceptually, the royalty free rights will be assigned to a non-profit organization (ie: GMIC) and transferred to Coalition members.
 - b. Non-coalition members will pay royalties for use of the IP.

3) **Recommendation for Funding of Initial Pre-competitive Project:**

- a. **Overview:** Based on the feedback received at the January 21, 2010 Interagency/Stakeholder meeting at ASTM (Washington, DC), the overarching goals of the Strength Research Coalition is in excellent alignment with the goals of the National Science Foundation (NSF): *fundamental research and education*. Although NSF grants represent one possible funding avenue, researchers are encouraged to explore all avenues for matching funds.
- b. **NSF Mechanics of Materials Program (MOM):**
 - i. Proposal Due Date: October 1, 2010
 - ii. This program supports fundamental research on solid mechanics including theoretical, analytical, and computational approaches, model-based simulation, and the development of constitutive models. Funding amount and number of awards not specified.
 - 1. Contact: Glaucio Paulino at gpaulino@nsf.gov
 - 2. http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13355
 - 3. Refer to Sol# PD-10-1630. (Grants.gov 1/18/10)
- c. **Materials World Network: Cooperative Activity in Materials Research between US Investigators and their Counterparts Abroad (MWN):**
 - i. Proposal Due Date: unknown
 - ii. Research is supported by the NSF Division of Materials Research (DMR): condensed matter physics, solid state and materials chemistry, polymers, biomaterials, metallic materials and nanostructures, ceramics, electronic and photonic materials, and condensed matter and materials theory. The NSF is working jointly with counterpart national, regional and multinational funding organizations

worldwide to enhance opportunities for collaborative activities in materials research and education between US investigators and their colleagues abroad. This solicitation includes joint activities between NSF and funding organizations in Africa, Asia, and Europe. Projects proposed are expected to offer students/junior researchers international research and education experiences.

1. Contact: Daniele Finotello at dfinotel@nsf.gov or Carmen I. Huber chuber@nsf.gov
 2. http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12820
 3. Refer to Solicitation # 09-600
- iii. NSF will accept proposals from US universities and colleges collaborating with researchers from the participating countries or regions. Concurrently, investigators at non-US research institutions should submit to the counterpart funding organization in their country or region a request for support of their side of the collaboration.

Appendix A:
Distribution List Name: Strength Steering Team (SST) as of 4/5/10

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