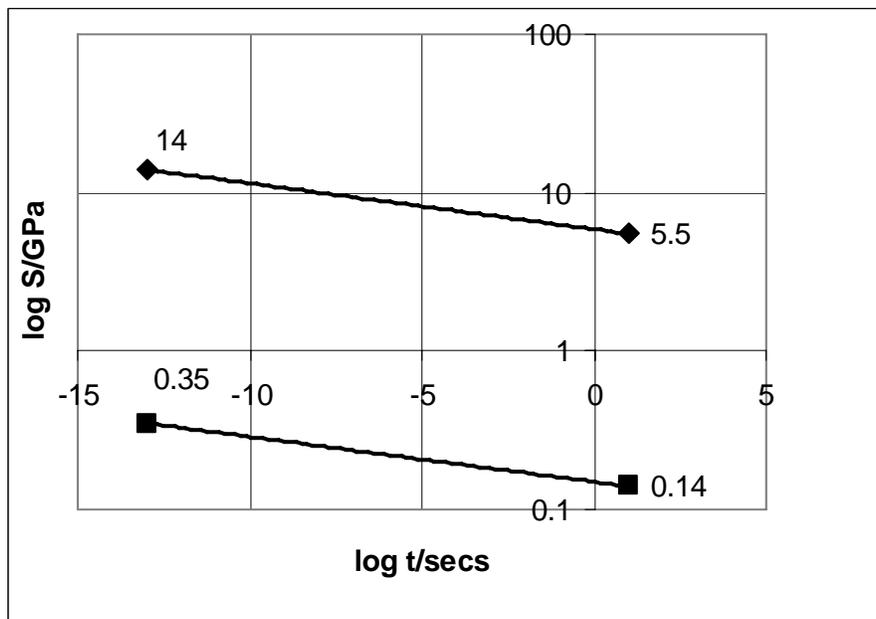


'NUCLEATION' OF A PROJECT TO IMPROVE THE PRACTICAL STRENGTH OF OXIDE GLASSES

The (Core Research Team) (CRT) of the "Glass Strength Initiative" has produced a 'White Paper' which discusses in detail the steps that should be taken to investigate fundamental issues in the area of 'strength of glasses'. Such studies should lead to a better understanding of the 'strength of glass' and consequently to the improvement of current techniques for increases in the 'practical' strength of glass products. Hopefully, this work would also lead to the development of new techniques and insights and thus to 'greater practical strengths'. Important issues discussed in the above 'White Paper' are described here with the aim of summarizing it while making the salient points clear.

We proposed an outline of the steps we believe are necessary to make progress in this area. The core of the idea is illustrated in the figure below. Here we plot the strength of a pristine silica fiber (diamonds) and below it (squares) the strength of that fiber after it has been damaged by 'contact' with a foreign object. It will be appreciated that this is a log-log plot. While a log-log plot is necessary in order to easily contain both sets of data, the enormous decrease in strength which has taken place is somewhat obscured. Actual strength values (in GPa) are shown at both the ends of the two curves. Thus a decrease in strength ~ 40 has resulted from the 'contact damage'. This is the 'normal' 'practical' strength of most glass objects! Also illustrated here is the 'time dependence' of strength, or fatigue. While fatigue is clearly also important, the magnitude of the effect is substantially less than that resulting from contact damage. For that reason, we consider understanding 'contact damage' to be critical and to be the first step.



Strength of pristine (diamonds) and damaged (squares) silica lightguide fibers.

1. Our first effort will be to understand the behavior of a standard soda lime silica glass and to make small modifications to the standard composition by looking at a fairly broad range of treatments.
2. Initially we will employ a cone indenter as an example of a pointed indenter. We will also study balls of different diameters as examples of blunt indenters. We intend to study the transition from blunt to sharp and in the case of blunt indenters the transition from elastic to 'plastic'.
3. We will start our study by looking at (a) a standard commercial soda lime glass, (b) one which has been thermally tempered, (c) one which has been ion exchange tempered and (d) one which has been coated with a range of soft and hard coatings.
4. We will evaluate the damage by strength testing, by the study of the stress birefringence produced by the indentation, with atomic force microscopy Raman, IR and optical and SEM microscopy of both the surface and fracture/subsurface of the indent.
5. On the basis of our findings here and as a result of studies of two point bending tests of these glasses, we will modify the composition in an effort to change/improve the behavior and to try to understand those changes.
6. We will carry out a range of modeling, from MD to FEA.

The completion of the above will provide not only a basic understanding of 'contact' damage, but also give substantial insight into the ability of the usual 'strengthening' techniques to alleviate this damage. The preliminary studies of coated and 'strengthened' surfaces will indicate the usefulness of these techniques in principle and hopefully suggest either modifications to these techniques, or perhaps new techniques and approaches to maintaining a greater fraction of the 'pristine' strength in practice.

May 20th PM.

1. Kurkjian - overall importance of and techniques for studying indentation/contact damage.
2. Brow – Inert intrinsic strength. Composition/processing effects and possible relaxation effects. Importance to damage processes.
3. Pantano – Coating parameters. Use of indentation in understanding coating behavior.
4. Varshneya – Modeling of ion exchange strengthening by use of indentation.
5. Gupta/Cormack – Description of the range of modeling techniques to be applied to contact damage problem.
6. Gulati – Review of real world problems and importance of this basic work.