Fictive Temperature of Silica Glass Fracture Surface

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Abstract:

Fictive temperature of fracture surface of silica glass was measured using IR reflection of a silica structural band. To probe the different depth of the surface, reflections at different reflection angles, 80 degree and 45 degree, were employed. The probe depths of the reflection at 80 degree and 45 degree are estimated as 0.02 μm and 0.07 μm, respectively. First, fictive temperature-reflection peak wavenumber calibration curves were established by determining the reflection peak wavenumbers corresponding to various fictive temperatures using the silica glass samples heat-treated at various temperatures for extended period of time. Then, reflection peak wavenumber of a rapidly fractured surface was measured and converted to the fictive temperature using the calibration curves. The obtained fictive temperature of the fracture surface was higher than the original fictive temperature of the glass by 55°C and 30°C estimated by 80 degree and 45 degree reflection angle, respectively. From these results, it was estimated that the fracture surface of ~ 0.1 μm has a higher fictive temperature than the original glass. This observation is consistent with our earlier observation that silica glass powder produced by crushing has a thin surface layer with high point defect concentration. The fracture surface energy appears to include the energy to produce these defects, in addition to breaking bonds at the fracture surface.

It has been proposed by some that plastic deformation of amorphous materials is accompanied by an increase of fictive temperature (plastic rejuvenation). And this was supported by the indentation hardness measurement around a large indent of both silica glass and soda-lime silicate glass. The high fictive temperature of the fracture surface of silica glass observed here is also consistent with the view that plastic deformation, or at least, inelastic, permanent deformation is taking place during the fracture.

<u>Questions to be answered:</u>

1.) What will be a topic stating an exceptional success to be published in a well known high ranking Research Journal in 2025 concerning your presented R&D field of work? Please think in headlines.

--Role of inelastic deformation of glasses prior to their fracture.

--Control of mechanical strength of oxide glasses through shear band engineering.

2.) Please name up to 10 future key challenges (till 2025) regarding your presented field of expertise and indicate please the specific year when you expect the topic to become a real bottleneck for the future developments.

1) Speciation of water in commercial oxide glasses: Hydroxyl (e.g. SiOH) vs. H_2O vs. $(H_2O)_2$ (2015).

2) Atomistic mechanism of mechanical strength reduction of oxide glasses by water (2015).

3) Role of plastic rejuvenation in glass polishing (2015).

3.) Concerning the topics, what would be
a) the key breakthrough and when is it likely to occur
b) what must happen concerning the research field if this topic will never be successful

a) Elimination of water from the glass surface.
b) Preparation of oxide glass surface which is immune to water or moisture.