000

Direct Observation of Indentation Deformation and Cracking of Silicate Glasses

Yoshida S., Kato M., Matsuoka J., Soga N.

Center for Glass Science and Technology, The University of Shiga Prefecture, Shiga, Japan

It has been well known that various types of cracks are observed on glass surface after indentation using a diamond indenter, such as Vickers indenter. Although such indentation cracks are sometimes used to model macroscopic fracture of glass, remarkable compositional variation of crack morphology prevents one from comparing brittleness or strength among various glasses. In order to understand such wide variety of indentation cracks on glass, it is essential to evaluate a sequence of cracking events of glass and to know what happens during the loading and unloading indentation cycle. However, there are very few reports on in-situ observation of indentation cracking on glass. An important paper is the one by Cook and Pharr (*J. Amer. Ceram. Soc.* **73** (1991)787.). Although they clearly showed cracking sequences of glasses and ceramics under Vickers indenter, low magnification of their experimental set-up made it difficult to see fine cracks or shear faults and to determine the contact region under the indenter during the indentation cycle.

In this study, a self-made indentation device is constructed in order to observe deformation and cracking of silicate glasses during loading and unloading. Using the device with a Vickers indenter, the sequence of micrographs at high magnification is successfully obtained during the indentation cycle. From direct observations, an experimental evidence of sinking-in, or pin-cushioning, during a loading half-cycle can be acquired for some silicate glasses and obvious shrinkage of the contact area is observed during an unloading half-cycle. Edge cracks, which are parallel to the edges of indentation imprint, are found to generate not only during loading, but also during unloading. It is also found that median/radial cracks generate during unloading, which is in good agreement with the previous reports.