In-situ observation of indentation deformation and cracking of silicate glasses using an indenter microscope

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Indentation cracking in glass is used to evaluate strength in glass. However, various types of cracks sometimes make it difficult for us to determine which glass is stronger or less brittle. In order to overcome this difficulty, it is essential to understand what happens in glass under the indenter during a loading and unloading cycle. In this study, a self-made indenter microscope is constructed in order to observe deformation and cracking of some glasses and single crystals during the loading and unloading cycle. The indenter microscope enables us to obtain the sequence of optical micrographs during the indentation cycle.

Using this set-up, it is found that the true contact area during indentation cannot be expected from the contact depth and the indenter geometry, and that the ridge lines of Vickers indenter affect the contact shape and area during indentation. Using the true contact area, in-situ Meyer hardness, which is the ratio of the indentation load to the contact area, can be obtained. Furthermore, an experimental evidence of sinking-in, or pin-cushioning, during a loading half-cycle can be acquired for some silicate glasses. It is found that the pile-up cannot be observed during loading for silicate glasses used. The pile-up is formed during unloading half cycle. It is suggested that the sinking-in behaviour affects the crack geometries and the cracking sequence. Edge cracks, which are parallel to the edges of indentation imprint, appear 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.