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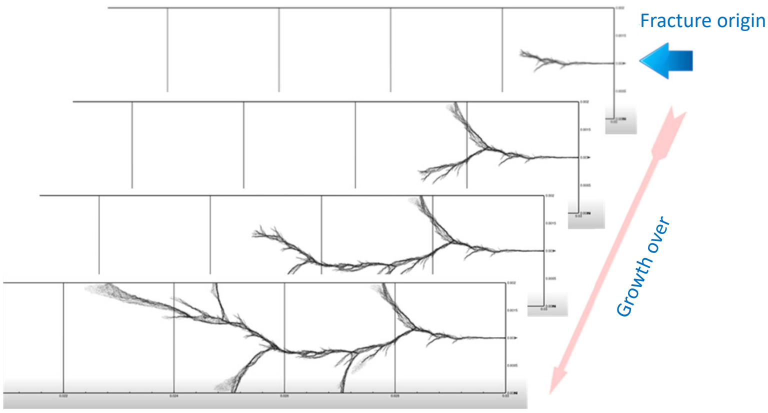
News Release

AGC and JAMSTEC Succeed in Developing World's First Highly Accurate Numerical Method to Predict Fracture Patterns in Chemically Strengthened Glass

Tokyo, August 4, 2021—AGC Inc.(AGC), a world-leading manufacturer of glass, chemicals and high-tech materials, in partnership with the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) have succeeded in simulating the fracture patterns of chemically strengthened glass—used for smartphone cover glass—in detail using a numerical analysis method, for the first time in the world.



Results of analysis

The greater the compression on the surface, the greater the strength of chemically strengthened glass. But on the other hand, tensile stress is formed inside the glass, which can cause numerous cracks and breakage if scratched deeply. Therefore, to produce chemically strengthened glass that is strong and resistant to breakage, it is important to design the appropriate stress patterns in the glass substrate.

Meanwhile, the crack propagation in the strengthened glass is an extremely complex phenomenon with intricate branching of cracks, which is difficult to reproduce using conventional simulation techniques. To optimize the reinforcing stress, trial-and-error using many experiments such as drop tests, analysis of cracks, and observation of the fracture origin was indispensable.

By combining AGC's fracture observation technology with JAMSTEC's numerical analysis technology that has been applied to soil and ground fracture analyses, the novel theory and simulation method, which can consider the effect of the stress field on the crack propagation, were developed. This is the first time in the world that the process of crack propagation and the branching patterns in chemically strengthened glass have been accurately reproduced using numerical simulations.

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State of stress in chemically tempered cover glass

This numerical analysis reproduces the crack propagation pattern well, which varies with the magnitude of stress stored in the strengthened glass (Figure 1). It also provides a detailed picture of stress waves during crack propagation with nanosecond time resolution (Figure 2).

Figure 1: Crack patterns of strengthened glass
(a) Observation experiments with high-speed camera (b) Numerical simulations
Residual stress level (Case I) Low, (Case II) Medium, (Case III) High

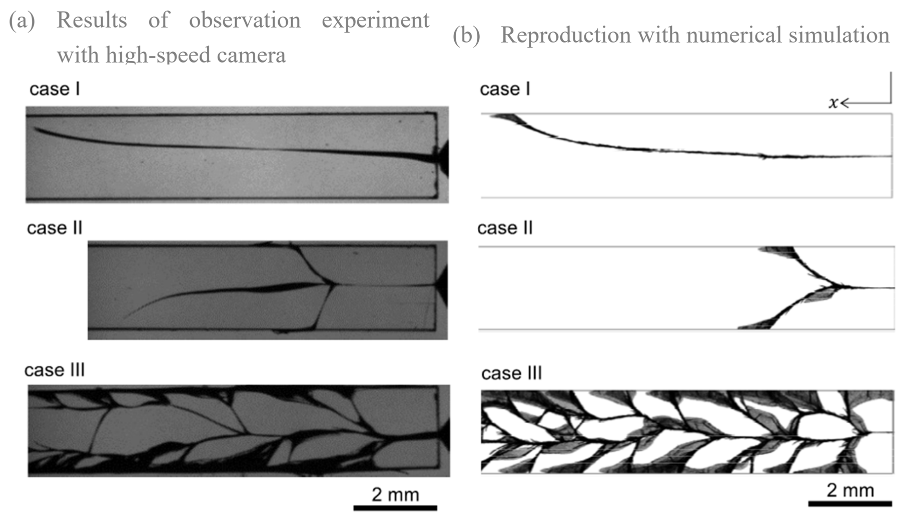

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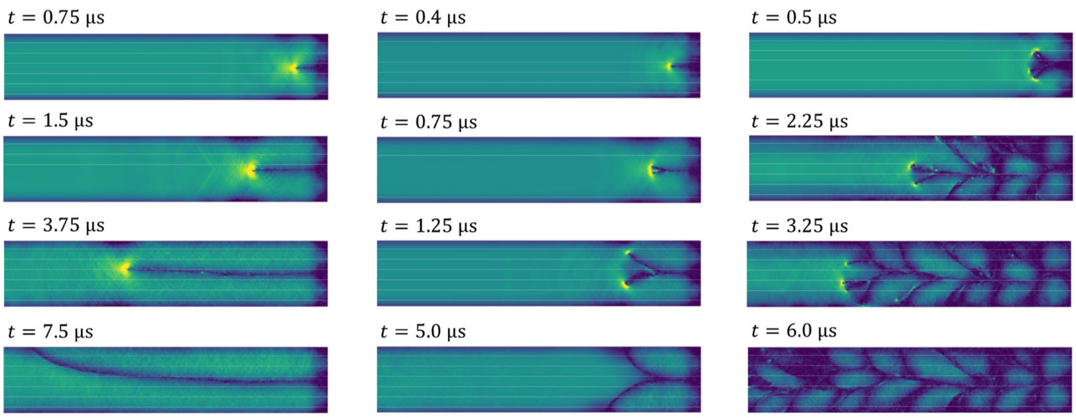
Figure 2: Numerical results of stress waves during fracture propagations

(a): Low residual stress (b): Meddium residual stress (c): High residual stress



These results will be published in *Physical Review Letters* and *Physical Review E* on August 4 (Japan Time).

Under its ***AGC plus 2.0*** management policy, the AGC Group will promote technological innovation to provide products and solutions that add new value by utilizing this method for the strength analysis of glass and other brittle and composite materials.

Sources

Title:

[1] Simulation of catastrophic failure in a residual stress field (Physical Review Letters)

[2] Mathematical model and numerical analysis method for dynamic fracture in a residual stress field (Physical Review E)

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A portion of this research was supported by a grant from the Japan Society for the Promotion of Research (JSPS) (topic number: 20K14812).

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