Effect of Experimental Parameters on Forming Prince Rupert's Drops for Maximum Strength and Toughness

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The history of modern glass starts 400 years ago with the creation of the world's first Prince Rupert's Drop – a thermally shocked glass bulb. It is created by dropping molten glass into distilled water causing the glass drop to cool rapidly, forming compressive stresses on the exterior of the drop. The inside of the drop cools at a slower rate forming internal tensile stress. The combination of compression and tension make the drop very difficult to break. This research seeks to enhance the strength of the drop by varying the concentrations of contaminants in solution. Poly vinyl acetate (PVA) as a contaminant suggested the largest increase in strength and was chosen as the principle variable to test. Specimens were prepared with varied concentrations of PVA (2-70%) at constant temperature and solvent composition. Drops were tested and measured under compression revealing the maximum strength, Young's Modulus, and toughness. As the concentration of PVA increased from 2% to 50%, there was an increase in maximum compressive strength and toughness; however, concentrations greater than 50% resulted in a decrease in mechanical performance. High-speed video analysis during compression testing showed that fracture occurs internally towards the end of the tail, suggesting the air gap has a great effect on the drops strength. Initial results from finite element analysis (FEA) indicate that the air bubble plays an important role in the fracture of the material.

Awards Won:
Society for Experimental Mechanics, Inc.: First Award of $2,500