Case Study #3: Pasteurizer Breakage

It was reported that 330 ml non-refillable, decorated beer bottles were breaking in the pasteurizer. The failures consisted of a single crack in the sidewall of the bottles with origins that were present under the ACL decoration. In order to properly diagnose the cause of the breakage, it was necessary to determine whether the tensile stresses were too high or whether the glass strengths were too low.

Based on the nature and simplicity of the fracture pattern, it was concluded that the bottles failed under the influence of a very low-level internal pressure. The absence of any mirrors at the fracture origins indicated that the failures occurred at very low stress magnitudes. Thus, the breakage was associated with inadequate glass surface strength.

Microscopic analyses indicated that shallow dwell marks were present on the fractured surfaces as shown in Figure 1. These dwell marks had been generated from numerous micro-cracks that were observed at the ACL-glass interface as shown in Figure 2. Thus, the source of the abnormally low glass strength was due to the presence of the micro-cracks that had extended from the ACL into the glass surface.

Analysis of ring sections cut from the vicinity of the fracture origins indicated that compressive stresses as high as -1113 psi (-77.9 kg_f/cm^2) were present in the glass immediately beneath the ACL. It can be inferred that tensile stresses of

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greater magnitudes would have been present in the ACL. Tensile stresses of such high magnitudes usually result in the creation of micro-cracks in the ACL as observed in this situation.

Thus, the cause of the breakage was due to a mis-match of the coefficient of thermal expansion (CTE) between the ACL and the glass substrate. In order to avoid this situation, it is necessary to assure that the CTE of the ACL and glass are equal or nearly equal in magnitude.

Figure 1

Dwell Mark at the ACL-Glass Interface

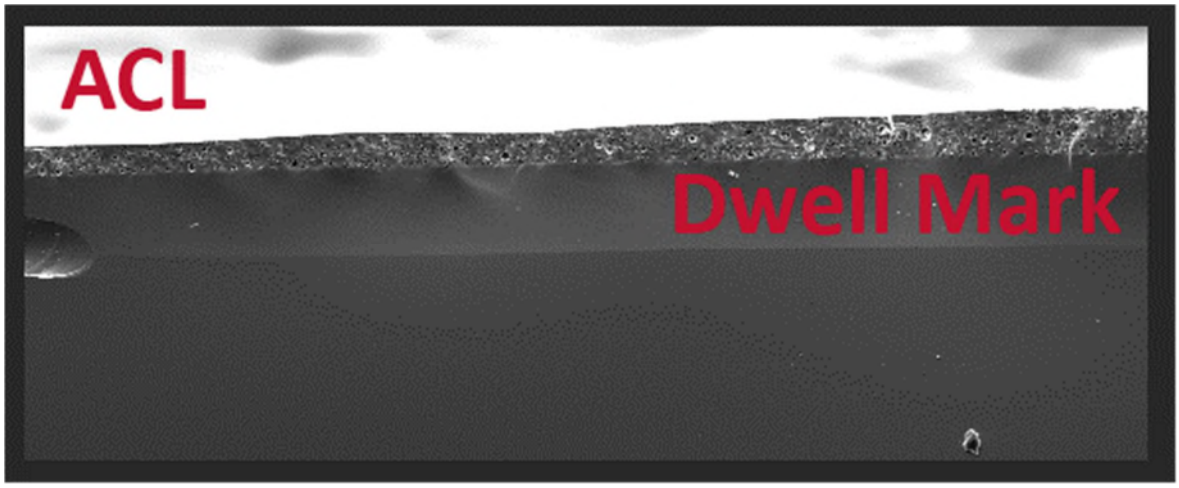

Figure 2

Micro-cracks at the Interface between

the ACL and Glass Substrate