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Knitline Failure Analysis

Keywords - Failure, Cross-sectioning, Knitline,

What Went Wrong?

An injection molded polypropylene part used in a conveyor application was experiencing cracking near the knitline of parts produced from a gray masterbatch resin. No cracking was observed in similar parts produced from a pre-compounded gray resin. All parts were manufactured in the same press/tool and similar process parameters were used for each resin type.

Evaluation

A microscopic examination of the fracture site in the failed component revealed that the crack was parallel to, but slightly offset from the visible knitline on the outer surface of the part, Figure 1. Inspection of the fracture surface showed the presence of a large internal void running through the mid-wall of the knitline region, Figure 2. Multiple crack initiation sites were observed extending from the edges of the void. The initiation sites showed features representative of a brittle, slow crack growth failure mechanism over time that was consistent with creep rupture. Thus, the crack developed within the part and propagated outward during use.

Polished cross-sections were prepared through the knitline regions of reference parts produced using the pre-compounded gray resin and the masterbatch gray resin, as shown in Figure 3. The distribution/mixing of the colorant in the pre-compounded resin component was excellent, while pigment streaking was readily apparent in the masterbatch resin component. Additionally, excellent knitline fusion was visible in the pre-compounded resin component, while the masterbatch resin component displayed a similar internal void at the knitline as the failed part.

Conclusion

It was the conclusion of the evaluation that the conveyor component failed as a result of voids within a poorly fused knitline. Inadequate mixing of the masterbatch resin during molding created differing flow and shrinkage properties in the masterbatch resin, which created the weak knitline when processed in a similar manner to the pre-compounded resin.

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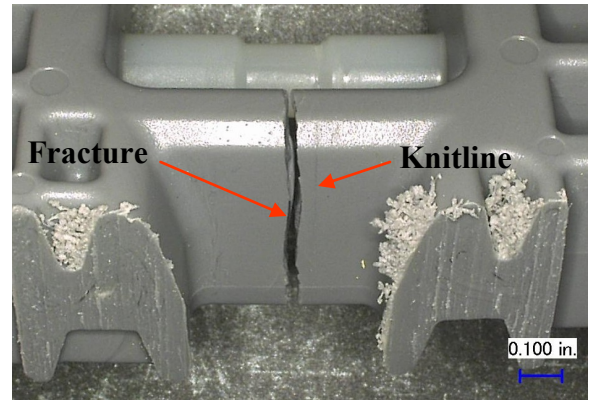


Figure 1: View of the fracture location in the part produced from a gray masterbatch resin.

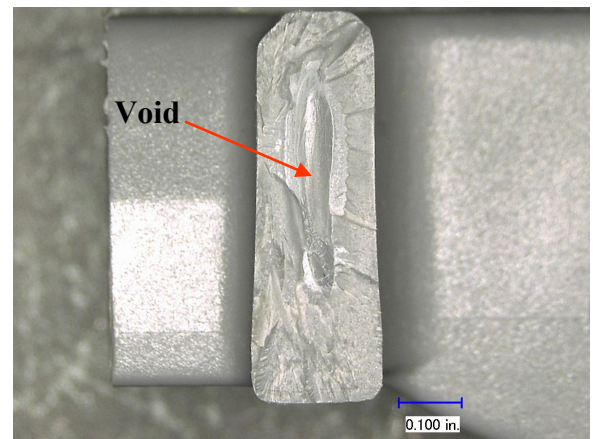


Figure 2: Micrograph view of the fracture surface of the failed part showing the presence of a large internal void at the approximate knitline location

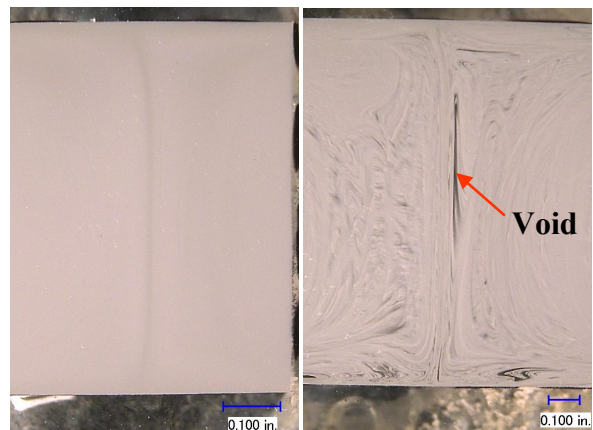


Figure 4: Micrograph views of polished cross-sections through the knitline regions of a part produced from a pre-compounded gray resin (left) and a masterbatch gray resin (right) showing poor mixing and an internal void at the knitline of the masterbatch gray part.