Optical Quality Validation for an Automotive Light Guide Component

Project Overview

Part: Automotive Interior Light Guide
Industry: Automotive Lighting and Interior Components
Application: Ambient lighting system inside vehicle cabin
Challenge: Optical appearance, dimensional stability, and production validation

Gege Mould developed and optimized an injection mold solution for an automotive interior light guide component used in a vehicle ambient lighting system.

The light guide is designed to distribute LED light evenly across the interior trim area, creating a consistent lighting effect for vehicle occupants. Because the part directly affects visible light performance, both optical quality and dimensional accuracy are critical.

Unlike standard plastic components, optical parts require strict control of material flow, cooling balance, surface quality, and molding conditions. Small defects that may not affect mechanical performance can create visible quality problems for the end customer.

Customer Challenge: Achieving Stable Optical Performance

During initial molding trials, the light guide showed several quality concerns:

- Uneven light transmission.
- Visible flow lines on the surface.
- Slight haze affecting clarity.
- Dimensional variation affecting assembly fit.

The customer needed a reliable molding solution that could achieve both visual quality and consistent production performance.

For automotive lighting components, appearance defects are especially important because they are directly visible inside the vehicle cabin.

The main concern was:

Could the mold produce optical parts with stable appearance, accurate dimensions, and repeatable quality for mass production?

Root Cause Analysis: Identifying the Source of Optical Defects

Gege Mould reviewed the mold design, material behavior, and molding process to identify the causes of the optical issues.

The analysis found several key factors:

1. Uneven Cooling and Temperature Variation

The original cooling layout created different cooling speeds across the optical surface.

Uneven cooling caused:

- Different shrinkage levels.
- Internal stress.
- Light transmission variation.
- Potential optical distortion.

For transparent optical parts, even small differences in internal stress can affect light performance.

2. Gate Location Influence

The gate position affected how molten material entered and filled the cavity.

An unbalanced filling pattern increased the possibility of:

- Flow marks.
- Weld lines.
- Residual stress.
- Birefringence.

3. Mold Surface and Process Conditions

Optical surfaces require excellent replication from the mold.

Incorrect molding conditions could create:

- Surface marks.
- Reduced clarity.
- Inconsistent gloss appearance.

Maintaining stable mold temperature and filling conditions was essential for achieving a uniform optical surface.

Mold and Process Improvements

Based on the analysis, Gege Mould applied targeted improvements to improve optical performance and dimensional stability.

Cooling System Optimization

The mold cooling design was improved to create a more balanced temperature distribution.

The optimization helped:

- Reduce uneven shrinkage.
- Lower internal stress.
- Improve dimensional consistency.

Gate and Filling Optimization

The gate location and filling process were adjusted to improve material flow balance.

This reduced:

- Flow lines.
- Filling pressure differences.
- Optical stress concentration.

Mold Temperature Control Improvement

The molding process was optimized with better temperature control to improve surface replication and transparency.

This helped achieve:

- Better surface quality.
- Improved clarity.
- More consistent optical appearance.

Process Window Optimization

Injection parameters were adjusted and validated, including:

- Injection speed.

- Holding pressure.
- Cooling time.
- Mold temperature.

The objective was to establish a stable process window suitable for repeated production.

Validation: Confirming Optical and Dimensional Performance

After mold improvements, Gege Mould completed multiple validation trials to confirm performance.

The validation included:

Optical Inspection

The light guide parts were checked for:

- Haze level.
- Light transmission consistency.
- Surface appearance.
- Visible defects.

Dimensional Validation

Critical dimensions were measured to confirm:

- Assembly fit.
- Part stability.
- Repeatability between trial samples.

Trial Stability Verification

Multiple molding cycles were completed to verify that improvements were consistent and not limited to a single trial condition.

The results confirmed that the mold and process could support stable production requirements.

Result: Improved Appearance and Production Confidence

After optimization, the automotive light guide achieved improved optical quality and dimensional stability.

Final trial results showed:

- Reduced visible flow lines and surface defects.
- Improved clarity and light transmission consistency.
- Reduced optical distortion caused by internal stress.
- Improved dimensional stability for assembly.
- Stable repeatability during production trials.

The customer gained confidence that the mold could deliver consistent optical parts suitable for automotive interior lighting applications.

Buyer Value

For T1 automotive suppliers, optical components require a mold partner with experience beyond basic injection molding.

Successful optical part production requires control of:

- Material flow behavior.
- Cooling balance.
- Mold surface quality.
- Optical stress.
- Dimensional accuracy.
- Production process stability.

This project demonstrates Gege Mould's ability to solve challenging optical molding issues through engineering analysis, mold optimization, and validation testing.

By controlling both appearance and performance requirements, Gege Mould helps customers reduce launch risks and achieve production-ready optical components.

Gege Mould Capability Highlight

Challenge: Optical defects and dimensional instability on an automotive light guide component.
Solution: Cooling optimization, gate adjustment, mold temperature control, and process validation.
Result: Improved optical appearance, stable dimensions, and reliable production performance.

Gege Mould supports automotive customers with precision molding solutions for lenses, light guides, transparent covers, and other high-quality optical components.