Acer Achieves Higher Quality Surface Finishes with Moldex3D DOE

Customer: Acer
Country: Taiwan
Industry: Electronics
Solution: Moldex3D eDesign; Expert Module

Image Courtesy of Acer

Founded in 1976, Acer is one of the world's top ICT companies and has a presence in over 160 countries today. From service-oriented technologies to the Internet of Things,gaming and virtual reality, Acer's 7,000+ employees are dedicated to the research, design, marketing, sale, and support of products and solutions that break barriers between people and technology. (Source: https://www.acer-group.com)

Executive Summary

Over the past few years, there has been a trend towards lighter and thinner tablets. Fiber reinforcement materials (PC+GF) and proper product design are the key factors to reducing weight while maintaining the desired product strength and stiffness. In-mold Roller (IMR) process is often used to decorate tablet products; however, possible defects such as ink wash-out and stress marks tend to occur in the IMR process. Acer used Moldex3D DOE (Design of Experiment) analysis to examine possible defects and achieve optimum gate design and process conditions.

Challenges

- Ink wash-out on the thin-wall injection molded base case (Fig. 1)
- Visible stress marks around the gate
- Stringent requirement for thickness (not exceeding 0.8mm)

Fig.1 The ink wash-out problem on the base case

Solutions

Utilizing Moldex3D DOE to achieve optimum gate design and process conditions.

Benefits

- Identify the best gate type to reduce shear stress and avoid ink wash-out
- Reduce the wall thickness significantly by 48%
- Reduce product weight by 40%

Case Study

The objective of this case is to solve the ink wash-out and stress marks in an ultra slim tablet. Through Moldex3D analysis, Acer identified high shear stress in the design. (Fig.3).

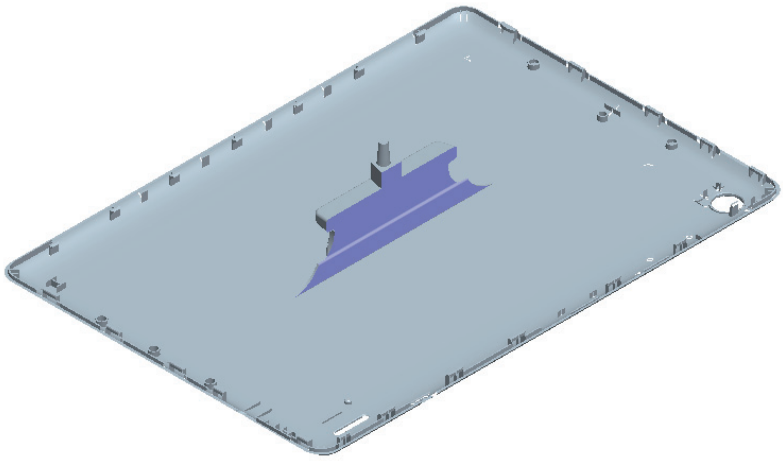

Fig.2 The original gate design

Acer set 11 sensor nodes on the gate (Fig. 3) and ran Moldex3D Flow analysis to check the shear rate of the sensors and compared it with the experimental results and they showed that the problematic areas have higher shear rate. Therefore, shear rate analysis results might serve as an indicator and can help minimize ink wash out.

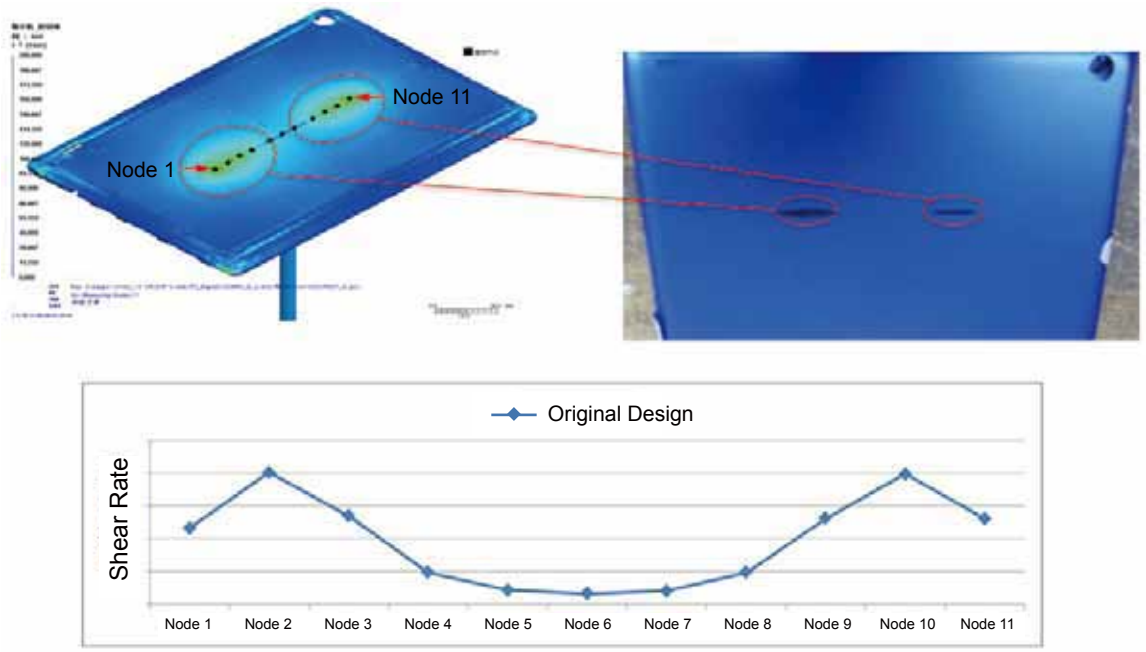

Fig.3 The shear rate result of the original design during the filling process

In order to reduce the shear stress developed across the gate and the mold cavity, Acer designed 7 sets of gates with different dimensions and locations and ran Moldex3D Flow analysis. After comparing the shear rate results, 4 designs were chosen as the optimal process designs.

Secondly, Acer performed Moldex3D DOE analysis to analyze the different types of meshes and gates in the 4 chosen designs, then set two quality factors: the shear rate and sprue pressure during the filling as smaller-the-better. Based on the Taguchi method, four control factors and four levels were selected for analyzing Signal/Noise (S/N) ratio (Table 1).

Quality Factor	Characteristic	Weighting (%)
Filling - Sheer rate distribution [1/sec]	The Smaller the Better	50%
Sprue injection pressure value [Mpa]	The Smaller the Better	50%

Control Factor / Order	Level 1	Level 2	Level 3	Level 4
Mesh	a-1	d-3	e-2	f-2
Melt Temp. (°C)	290	300	310	320
Mold Temp. (°C)	45	50	55	60
Max. Flow Rate(%)	20	25	30	35

Table 1 The DOE method analysis data of the quality factors and the control factors

According to the simulation results shown in Fig. 4 and Fig. 5, the S/N ratios indicate that the melt temperature and the flow rate are the main control factors of the ink wash-out problem.

Filling - Shear rate distribution (Mpa)

Control Factor	A. Mesh	B. Melt Temp.	C. Mold Temp.	D. Max Flow rate
1	2.23945	-0.3266	-1.223	-4.0065
2	5.45684	2.29562	2.13897	2.98867
3	-1.5981	2.73937	3.00874	5.51633
4	2.72897	4.11881	4.90261	4.32866
S/N Ratio	7.05494	4.44546	6.12558	9.52283

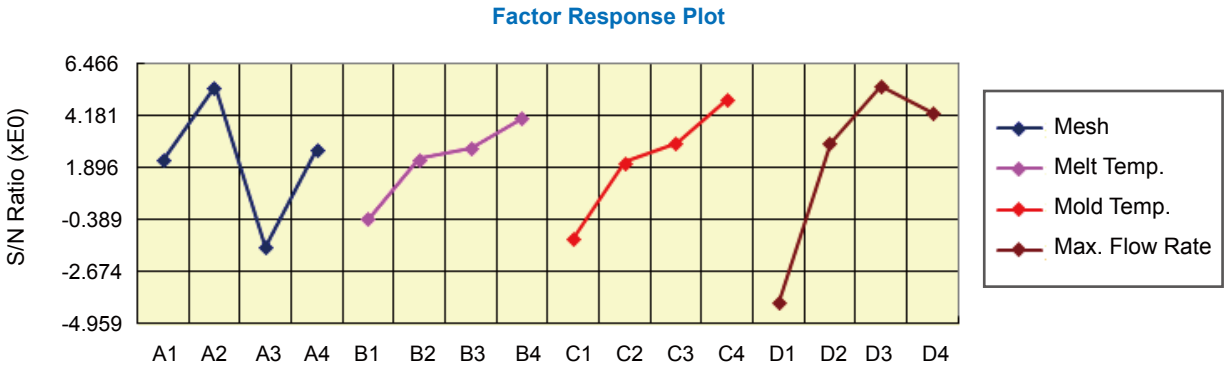

Fig. 4 The S/N Ratio data of shear rate distribution at filling stage

Spure injection pressure value (Mpa)

Control Factor	A. Mesh	B. Melt Temp.	C. Mold Temp.	D. Max Flow rate
1	-38.199	-40.437	-38.521	-38.121
2	-38.648	-38.998	-38.401	-38.073
3	-38.073	-37.516	-38.177	-38.345
4	-38.216	-36.185	-38.038	-38.598
S/N Ratio	0.57522	4.25226	0.48371	0.52553

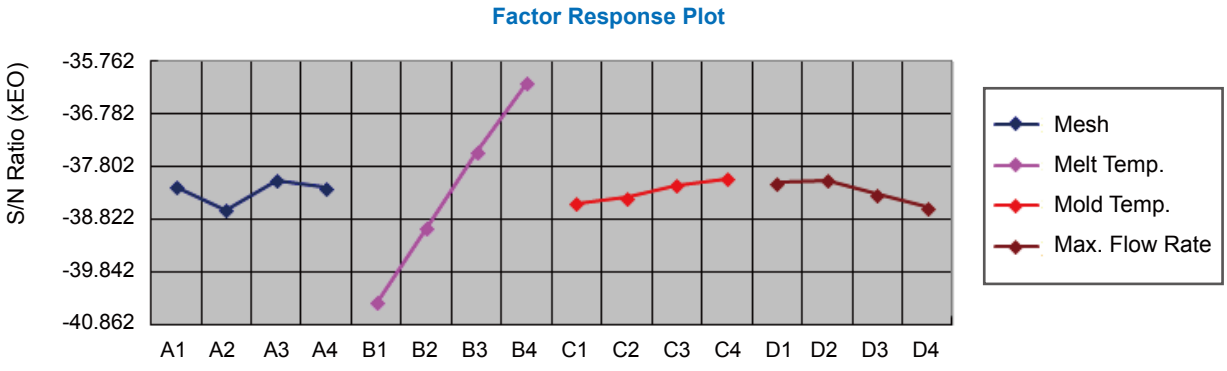

Fig. 5 The S/N Ratio data of sprue injection pressure at filling stage

Moldex3D Expert also helped identify the best run, which consists of the optimum processing parameters (Fig. 6). By comparing the best and the worst run, Acer found that in the worst run, the shear rate curve of the gate area is very steep while the curve of the best run is relatively smooth (Fig. 7). Based on the analysis results, Acer changed the gate design and then reworked the design, successfully solving the ink wash-out problem (Fig. 8).

	A. Mesh	B. Melt Temp.	C. Mold Temp.	D. Max. Flow Rate	Shear Stress (MPa)	Sprue Injection Pressure Value (MPa)
Worst Run	f-1	300	50	25	2.40365	87.3878
Best Fun	d-3	320	60	30	0.432175	65.6163

Fig. 6 The worst and best design run comparison

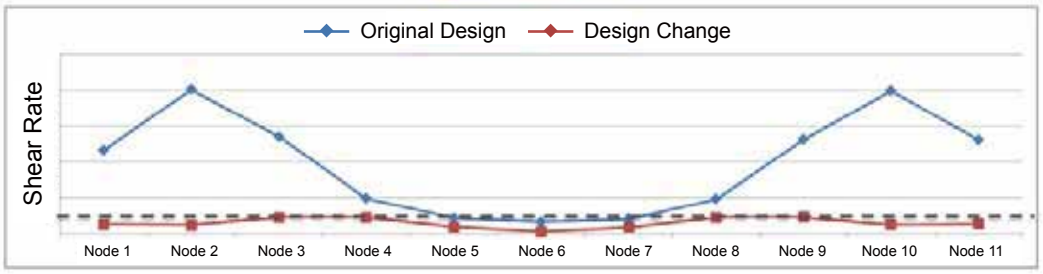

Fig. 7 Comparison of shear rate curves between the best design and the worst one.

Fig. 8 The ink wash-out problem has been successfully reduced.

Results

Moldex3D's virtual molding technology helped Acer obtain optimal mold designs in the shortest time possible. The thickness of the base case of the tablet has been reduced from 1.3~1.55mm to 0.8~0.95mm. The product weight has been reduced by 24%~40%, and the product thickness has been reduced 26.9%~48.4%. With the help of Moldex3D solutions, Acer is able to cut costly mistakes and gain a competitive advantage.

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