

## Chapter 4

### Research Result

#### Quality of Silver Powder Before and After the Implementation of X Technology

The quality of silver powder can be assessed by comparing the silver powder product data for the entire year of 2022 and June 2023 before and after the implementation of X technology, as shown in Table 4.1

**Table 4.1** Statistical table of qualified rate and direct yield of products before and after application of X technology in 2022 and 2023

Qualified rate and direct yield	Before applying Technology X from January to June in 2022	After applying Technology X from January to June 2023	Data comparison
Production batch (piece)	4314	4480	Up 3.85%
Qualified lot (piece)	4221	4355	Up 3.17%
Input weight (kg)	103536	111417.668	Up 7.61%
Direct weight (kg)	102059.422	110258.537	Up 8.03%
Direct return rate (%)	98.57	98.96	Up 0.39%
Pass rate (%)	97.84	99	Up 1.16%

After the implementation of X technology, the quality of silver powder products improved, with the qualification rate and direct yield increasing by 1.16% and 0.39%, respectively, compared to the first six months of 2022. This outcome aligns with the results obtained from interviews, particularly regarding the significance of specific surface area, particle size distribution, and ignition loss in assessing the quality of silver powder. Key informants emphasized that these factors are very important.

Specific surface area signifies the surface area per unit mass of silver powder. The larger the specific surface area, the smaller the particle size of silver powder, and the higher the oil absorption rate in the slurry system. Particle size distribution reveals the size and distribution of silver powder particles.

Implementation personnel Mr. Zhang said that:

*“It is very important. As far as personal understanding is concerned, the larger the specific surface area, the smaller the particle size of silver powder, which has a significant impact on the oil absorption of subsequent customers' silver slurry. The measurement of ignition loss affects the purity of silver powder, and the particle size distribution reflects dispersibility”*

For silver powder of the same grade, the smaller the particle size, the better the dispersion. If the particle size is either too small or too large, it will affect the sintering performance and the electrical performance of the battery. Therefore, it is necessary to choose an appropriate particle size distribution range. Burn loss is the weight loss of silver powder under specific conditions (600 °C, 40 minutes), which is an important indicator for evaluating the antioxidant performance of silver powder.

Implementation personnel Mr. Gong concluded like:

*“Very important, it is an important control indicator in our production process”*

And Manager Mr. Wang also agreed with them:

*“The specific surface area represents the surface area per unit mass of silver powder. The larger the specific surface area, the smaller the particle size of silver powder, and the higher the oil absorption rate in the slurry system; The particle size distribution reflects the size and distribution of silver powder particles. For silver powder of the same grade, the smaller the particle size, the better the dispersion. Burn loss refers to the weight loss of silver powder under specific conditions (600 °C, 40 minutes).”*

The larger the specific surface area, the smaller the particle size of silver powder, and the higher the oil absorption rate in the slurry system. This is beneficial for improving the photoelectric conversion efficiency of solar cells, but it should be controlled within a certain range. For silver powder of the same grade, the smaller the particle size distribution, the better the dispersion, which is beneficial for improving the conductivity of the slurry. If the particle size distribution is too small or too large, it will affect the sintering performance and the electrical performance of the battery. The amount of burning loss affects its conductivity, oxidation resistance, and photoelectric conversion efficiency.

Implementation personnel Mr. Yang said:

*“There is a correlation between surface area and particle size distribution, and ignition loss should be well controlled during the drying process”*

Related personnel Ms. Liu described it more detail:

*“The larger the specific surface area, the greater the surface energy, and the higher the sintering activity, which can effectively reduce the sintering temperature. The silver slurry made with a narrow particle size distribution is closely connected and evenly distributed after sintering, forming a relatively dense conductive network with relatively small square resistance of the silver film. When sintering, if the oxidation and burning loss of silver powder is small, the density of silver slurry is high, the film layer is dense, and the conductivity is good.”*

Specific techniques and methods were employed to measure and analyze the specific surface area, particle size distribution, and burning reduction ratio of silver powder. Specialized testing equipment was used for these tests, and dedicated personnel were responsible for the procedures. The specific equipment used included:

- 1) 2000E laser particle size distribution instrument
- 2) 3H-2000A intelligent fully automatic nitrogen adsorption surface area analyzer
- 3) Electric heating constant-temperature drying oven
- 4) Mettler Toledo ME204 electronic analytical balance.

For this aspect, implementation personnel Mr. Zhang said:

*“2000E laser particle size distribution instrument, 3H intelligent fully automatic nitrogen adsorption surface area analyzer, electric heating constant temperature drying oven, electronic analytical balance”*

The relationship between key performance indicators and the quality of silver powder is significant. The specific surface area is closely linked to the mass density of silver powder. The larger the specific surface area, the higher the photoelectric conversion rate of solar cells becomes. However, if it becomes excessively large, it can decrease the sintering activity of the silver slurry. After the implementation of X technology,

control over surface area and particle size distribution has greatly improved, resulting in stable product quality.

Such as Mr. Chen, a related person, said that:

*“The larger the specific surface area, the smaller the particle size of silver powder, and the higher the oil absorption rate in the slurry system. This is beneficial for improving the photoelectric conversion efficiency of solar cells, but it should be controlled within a certain range. For silver powder of the same grade, the smaller the particle size distribution, the better the dispersion, which is beneficial for improving the conductivity of the slurry. The amount of burning loss affects its conductivity and photoelectric conversion efficiency.”*

Mr. Wang, a implementation people, also said:

*“The larger the specific surface area, the smaller the particle size of silver powder, and the higher the oil absorption rate in the slurry system. This is beneficial for improving the photoelectric conversion efficiency of solar cells, but it should be controlled within a certain range. For silver powder of the same grade, the smaller the particle size distribution, the better the dispersion, which is beneficial for improving the conductivity of the slurry. The amount of burning loss affects its conductivity and photoelectric conversion efficiency.”*

In the context of industry standards or guidelines that define acceptable ranges or specifications for specific surface area, particle size distribution, and ignition loss in silver powder, it is found that there is no clear industry standard or guideline definition. Instead, the company establishes its own technical indicator control standard range based on customer application requirements and the product performance structure of ABC Company.

Just like manage Ms. Li said:

*“There is no clear industry standard or guideline definition”*

## Production Cost and Profit Margin of Silver Powder Products After the Application of X Technology by the ABC Company

### 1. Production cost of silver powder products after the application of X technology by the ABC Company

Analysis of the cost composition of the application of X technology by ABC Company, including:

#### 1) Production cost:

The theoretical raw material cost to produce 1 kg of silver powder is calculated as follows:  $35 \text{ RMB/kg (silver nitrate processing fee)} / 63.5\% \text{ (silver content)} / 99.8\% \text{ (silver nitrate content)} = 55.23 \text{ RMB/kg}$ . The actual cost, calculated based on a unit consumption factor of 1.017, is as follows:  $35 \text{ RMB/kg (silver nitrate processing fee)} / 63.5\% / 99.8\% * 1.017 \text{ (unit consumption)} = 56.18 \text{ RMB/kg (fixed)}$ .

The cost of auxiliary materials for producing 1 kg of silver powder using the original process is 25 RMB/kg (fixed). After implementing X technology, the cost of auxiliary materials and the production process increases by 2 RMB/kg, resulting in a total cost of 27 RMB/kg for auxiliary materials after the application of X technology.

Regarding manufacturing costs, in the first half of 2023 after implementing X Technology, expenses such as energy and power consumption, staff salaries, training expenses, and processing and maintenance expenses remained relatively stable compared to the same period last year. However, depreciation, testing expenses, safety expenses, and travel expenses saw a slight increase.

The manufacturing cost per 1 kg of silver powder produced was approximately 74.7 RMB/kg, reflecting a year-on-year increase of 3.09 RMB/kg (compared to a manufacturing cost of 71.61 RMB/kg for the same period in 2022).

In summary, the cost of silver powder in 2022 was RMB 152.79/kg, and after the introduction of X technology in 2023, the cost of silver powder is RMB 157.88/kg. With the continuous improvement of production supply, it is expected that the manufacturing cost will further decrease throughout 2023, and the production cost of silver powder will also decrease.

**Table 4.2** Results of X technology's impact on ABC Company's production cost

		Coefficients (B)	Standard Error	Standardized Coefficients ( $\beta$ )	t- value	p-value
<b>Before adoption</b>						
HB	Burn reduction ratio	0.084	0.016	0.071	2.231	0.084
	Specific surface area	0.146	0.021	0.117	2.122	0.102
	Particle size diameter	0.112	0.017	0.099	2.791	0.046*
QB	Burn reduction ratio	0.108	0.024	0.084	2.301	0.078
	Specific surface area	0.213	0.018	0.197	2.229	0.086
	Particle size diameter	0.186	0.028	0.162	2.678	0.063
SH-QB	Burn down ratio	0.167	0.037	0.144	2.218	0.088
	Specific surface area	0.236	0.016	0.213	2.279	0.076
	Particle size diameter	0.218	0.018	0.185	2.209	0.087
<b>After adoption</b>						
HB	Burn reduction ratio	0.104	0.012	0.082	2.812	0.044*
	Specific surface area	0.161	0.028	0.149	2.308	0.084
	Particle size diameter	0.102	0.023	0.0081	2.218	0.088
QB	Burn reduction ratio	0.118	0.022	0.101	2.301	0.078
	Specific surface area	0.183	0.018	0.162	2.229	0.086
	Particle size diameter	0.186	0.018	0.165	2.233	0.083
SH-QB	Burn down ratio	0.197	0.027	0.172	2.791	0.046*
	Specific surface area	0.186	0.017	0.163	2.976	0.034
	Particle size diameter	0.198	0.018	0.174	2.308	0.084

Note: \* p<0.05

As evident from the table above, following the adoption of X technology, notable changes have occurred in the impact of ABC Company's silver powder products on the company's production costs. On one hand, the influence coefficient of the burning reduction ratio in each product system has increased, while the influence coefficient of the corresponding specific surface area and particle diameter has decreased. This suggests that the new technology places a greater emphasis on optimizing the burning reduction ratio to reduce production costs. This optimization aims to improve the overall process technology and, consequently, reduce the expenses associated with any pre-existing processes. Furthermore, alignment with customer safety requirements indicates that X technology is indeed capable of achieving the dual objectives of cost savings and enhanced customer appeal.

The research findings mentioned here are consistent with the data obtained from interviews. When asked, "What is the impact of implementing X technology on the production cost of silver powder products?" the response indicates that the production cost has slightly increased compared to before the implementation of X technology, with a cost increase of about 1-2 RMB per kilogram of silver powder. However, when compared to the advantages of an improved qualification rate, increased sales volume, and higher selling prices, the impact on the production cost is relatively minimal.

Mr. Wang, a manager of ABC, said that:

*“ The production cost has slightly increased, but compared to the advantages of improved qualification rate, increased sales volume, and increased selling price, it has little impact on the production cost ”*

The results of the research show that there are several key factors or ingredients that affect the production cost of silver powder products. These factors include the price of metal silver, the cost of auxiliary materials, product quality, production processes and equipment, energy consumption, and production efficiency.

Mr. Wang also talked about the key factors just like:

*“ The impact of price changes in raw materials (silver/silver nitrate), equipment and processes, energy consumption, product quality, etc ”*

And consistency with Mr. Chen said:

*“Depreciation of raw and auxiliary materials, processes, and equipment”*

2) Cost reduction and efficiency increase

The qualified rate of silver powder products increased by 1.16%. In 2023, the production of 110,258.537 kg of silver powder resulted in sales of 1,190 kg of new products, generating sales revenue of approximately RMB 6,783,000 and increasing profit by RMB 201 million. If the output is increased by 0.17%, sales revenue could rise by about RMB 1.068 million, and profit could increase by RMB 310,000. Simultaneously, it can further reduce costs.

**2. Profit margin of silver powder products after the application of X technology by the ABC Company**

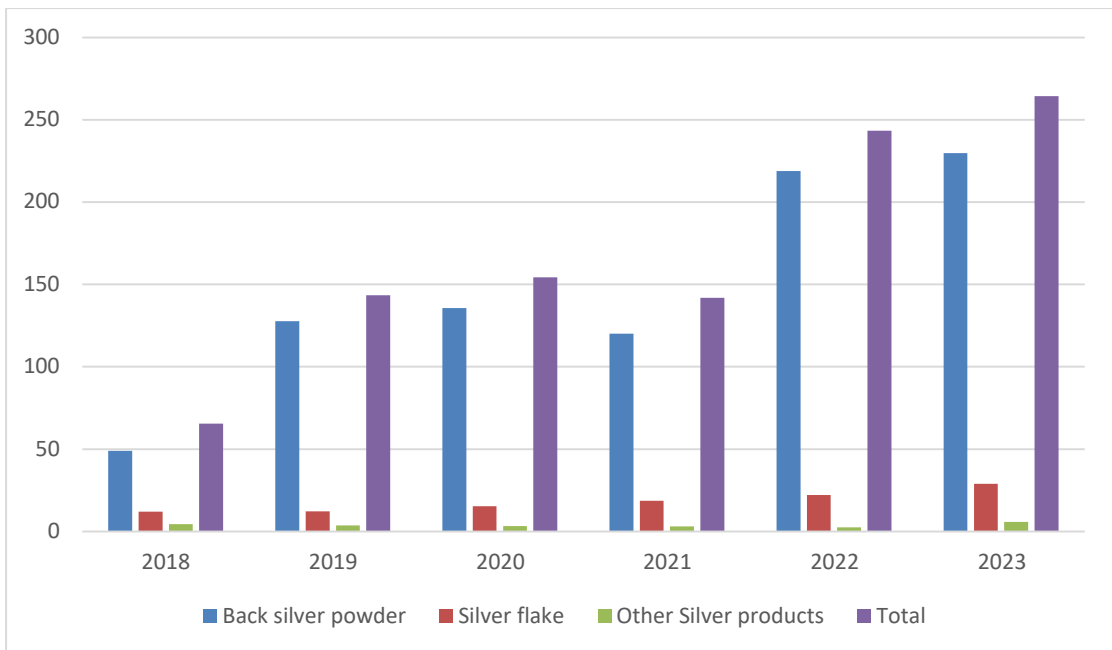
1) Sales data statistics

Statistics on ABC Company's sales data in recent years, from 2018 to the first half of 2023, are presented in Table 4.3.

**Table 4.3** Sales statistics of various silver products of ABC Company from 2018 to 2023

Time	2018	2019	2020	2021	2022	2023
Back silver powder	48981	127628	13571	120056	218803	229722
Silver flake	12021	12289	15271	18696	22122	28874
Other Silver products	4500	3600	3360	3100	2500	5720
Total	65502	143517	154341	141852	243425	264316





**Figure 4.1** Sales statistics of various silver powder products of ABC Company from 2018 to 2023

hotovoltaic technology, ABC Company has gradually kept pace with the market and continued to achieve technological innovations, resulting in a new record high for the total amount of silver powder produced. Based on the sales data from January to June 2023 and the current market analysis, ABC Company is expected to achieve sales of more than 260,000 kg of products for the entire year. During January to June 2023, a cumulative sale of 132,158 kg of products was achieved, representing a year-on-year increase of 19.09%, with a 17.12% year-on-year increase for silver powder.

Building on our cooperation and mutual progress with Guangzhou Ruxing, the company has expanded the application of X technology to three silver powder customers (Wuxi Ruxing, Wuhan Shuomet, and Xi'an Chuanglian), resulting in cumulative product sales exceeding 6,000 kg. Sales data analysis indicates that the application of X technology has increased ABC Company's market share.

In terms of profit margin, the application of X technology allowed for a 20 RMB per kilogram increase in the sales price of silver powder (compared to the original process with a profit margin of 50 RMB per kilogram). After accounting for the increased production cost, the profit margin for silver powder increased by 16.91 RMB per kilogram, representing a 33.82% year-on-year increase.

2) Statistics on the supply of silver powder on the back

We dynamically compared the proportion of silver powder used by 3 customers among the top 10 domestic silver paste manufacturers. We compiled statistics on the silver powder supply of ABC Company, as shown in Table 4.4.

**Table 4.4** Statistics of silver powder supply ratio to major customers

One year	2018	2019	2020	2021	2022	January-June 2023
Guangzhou Ruxing	48981	120000	120000	114000	214803	106461
Supply ratio	0.1224	0.2181	0.2	0.19	0.31	There is no data available at this time
Wuhan Youle	---	628	2710	6056	4000	2400
Supply ratio	---	---	---	---	---	---
Dongshu, Sichuan Province	0	7000	13000	0	0	0
Supply ratio	---	---	---	---	---	0
New customers (Wuxi Ruxing, Wuhan Shuomite, etc.)	---	---	---	---	---	6000
Supply ratio	---	---	---	---	---	---

Guangzhou Ruxing did not disclose the supply ratio of each supplier in the first half of the year. However, based on the analysis of the total supply quantity, the supply ratio should be on the rise, which further indicates that the market share has increased.

When considering the data obtained from the interviews, it can be observed that they are consistent, as can be seen when asking, "Has there been any significant change in the profit margin of silver powder products since the adoption of X technology?" The response obtained is as follows: The sales price of silver powder products using X technology increased by 20-30 RMB/kg year-on-year. After the increase in sales, the profit increased significantly, which can be a new profit growth point for ABC Company. Additionally, Mr. Wang stated:

*“Significant reduction in return and exchange rates after the application of X technology”*

Besides, managers like Ms. Li and Mr. Wang both said:

*“The sales price of silver powder products using X technology increased by 20-30 RMB /kg year-on-year, and after the increase in sales, the profit increased significantly”*

3) Challenges or obstacles in cost management and profitability that may arise after the implementation of Technology X.

In the early stages of implementation, there were uncertainties, such as significant R&D investment, increased production costs, and long customer verification cycles. However, in response to the continuous upgrading of PERC technology, Guangzhou Ruxing and other customers collaborated with ABC Company to address risks and challenges. The company used a relatively short time to complete product research and development and passed customer verification, resulting in large-scale production and sales. This achievement marked another new growth point in the solar photovoltaic field of New Materials Company

For this aspect, manager Mr. Wang expressed it in details:

*“In the early stages of implementation, there were increasing uncertainties such as high R&D investment, increased production costs, and long customer validation cycles. However, in the face of the continuous upgrading of PERC technology, Guangzhou Ruxing and other customers worked together with ABC Company to address risks and challenges. The company completed product research and development in a relatively short period of time and passed customer validation, forming large-scale production and sales, becoming another new growth point in the solar photovoltaic field of new materials companies”*

### **Benefits of Applying X Technology to ABC Company Competitiveness, in Terms of Customer Product System, Production Cost, Profit Margin and Market Share**

The impact of implementing X technology on the customer product system of silver powder products is illustrated in Table 4.5

**Table 4.5** Impact results of X technology on ABC Company's customer product system

		Coefficient	Standard Error	Standardized Coefficients ( $\beta$ )	t-value	p-value	Coefficient	Standard Error	Standardized Coefficients ( $\beta$ )	t-value	p-value
		Before adoption					After adoption				
HB	Burn reduction ratio	0.086	0.016	0.077	2.154	0.095	0.109	0.012	0.879	2.812	0.045*
	Specific surface area	0.116	0.021	0.102	2.121	0.102	0.104	0.024	0.874	2.231	0.085
	Particle size diameter	0.096	0.017	0.082	2.762	0.056	0.103	0.023	0.872	2.914	0.031*
QB	Burn reduction ratio	0.094	0.025	0.079	2.304	0.074	0.121	0.022	0.109	2.845	0.041*
	Specific surface area	0.204	0.019	0.167	2.236	0.086	0.177	0.012	0.172	2.836	0.043*
	Particle size diameter	0.187	0.024	0.168	2.698	0.063	0.175	0.015	0.169	2.841	0.042*
SH-QB	Burn down ratio	0.137	0.037	0.116	2.237	0.084	0.179	0.023	0.164	2.762	0.056
	Specific surface area	0.216	0.011	0.195	2.468	0.074	0.165	0.016	0.148	2.879	0.035*
	Particle size diameter	0.203	0.015	0.184	2.781	0.049*	0.189	0.011	0.173	2.812	0.045*

Note: \* p<0.05

As can be seen from the table above, after the adoption of X technology, the influence of ABC Company's silver powder products on the customer's product system has changed significantly. On the one hand, in each product system, both the influence coefficient of the ablation ratio and the P-value representing the significance have significantly increased, indicating that after the adoption of X technology, the impact from the burn reduction ratio has significantly increased, and customers are more inclined to new products that can reduce the burn reduction ratio, and the significance of this result has been statistically verified according to the P-value. Therefore, the importance and effectiveness of the burn reduction ratio of the product system after the adoption of X technology have been improved for the product system of major customers. In addition, the influence coefficients of specific surface area and particle size both show a decreasing trend, and this result is also significant. This shows that after the adoption of the new technology, the impact of the specific surface area and particle size diameter on the customer's product system is weakened, and the attraction of the new technology to the main customer is still focused on its ability to decrease the burning ratio, combined with the technical factors, the improvement of the burn reduction ratio, which in turn helps to better remove moisture and overall product enhancement, thereby improving production safety. This shows that the main customers of ABC company attach more importance to production safety, which has certain significance for the comparison with the whole industry.

However, for the specific surface area and particle size that can improve product performance, customers pay less attention to them after transitioning to products modified by X technology. This does not mean that X technology is less attractable. Rather, it reflects the customer's consistent trust in the quality of ABC's products. Therefore, after adopting X technology, customers will be more inclined to prioritize the security aspects of technological improvements.

**Table 4.6** Effect of X technology on ABC Company's Market Share

		Coefficient	Standard Error	Standardized Coefficients ( $\beta$ )	t-value	p-value	Coefficient	Standard Error	Standardized Coefficients ( $\beta$ )	t-value	p-value
Before adoption						After adoption					
HB	Burn reduction ratio	0.103	0.022	0.096	4.116	0.025*	0.203	0.022	0.189	3.642	0.033*
	Specific surface area	0.189	0.019	0.165	4.11	0.026*	0.195	0.026	0.176	4.253	0.023*
	Particle size diameter	0.173	0.029	0.142	4.095	0.032*	0.202	0.023	0.186	2.561	0.062
QB	Burn reduction ratio	0.206	0.023	0.173	2.154	0.096	0.226	0.022	0.202	2.557	0.066
	Specific surface area	0.113	0.022	0.104	2.431	0.082	0.093	0.022	0.079	2.771	0.052
	Particle size diameter	0.203	0.026	0.169	4.265	0.021*	0.182	0.026	0.167	2.777	0.051
SH-	Burn down ratio	0.179	0.039	0.159	2.479	0.075	0.249	0.029	0.213	4.176	0.029*
QB	Specific surface area	0.203	0.022	0.187	2.501	0.089	0.182	0.029	0.166	3.356	0.039*
	Particle size diameter	0.208	0.026	0.191	2.613	0.063	0.228	0.026	0.205	2.924	0.041*

Note: \* p<0.05

As can be seen from the table above, after the adoption of X technology, the impact of ABC Company's silver powder products on the company's market share undergoes different changes compared to several previous variables. On one hand, in each product category, the influence coefficient of the ablation ratio on market share has significantly increased (P-value less than 0.05), and the ablation ratio coefficient is the largest among the three coefficients, indicating that the ablation ratio has the most substantial impact on ABC Company's market share among the three indicators. However, the influence coefficient of the specific surface area on market share decreases, signifying a weakening influence of this variable. Nevertheless, the influence coefficient of particle size on market share has significantly increased in conjunction with the cauterization ratio. This suggests that, after the adoption of X technology, the market is more optimistic about the prospects of optimizing technology to reduce the particle size diameter effectively, while it places less emphasis on the specific surface area.

From this perspective, in addition to giving greater importance to technical safety (where the burning ratio coefficient is the largest), the market also places more emphasis on particle size diameter, presenting another crucial optimization direction for ABC Company's future enhancements to X technology.

As is evident from the table above, following the implementation of X technology, ABC Company's silver powder products have undergone a change in profit margin like that of the cost rate. In each product system, the influence coefficient of the reduction ratio in burning on profit margin has increased significantly, along with its significance, while the coefficients of specific surface area and particle diameter have decreased. This indicates that the new technology places greater emphasis on optimizing the reduction ratio in burning, becoming the primary driver of profit for ABC Company's silver powder products. From this perspective, technological improvement has a clear and positive impact on ABC Company's profitability. Simultaneously, it underscores the substantial effect of eliminating potential additional processes in the original system on overall profit. By reducing these costs, the company has significantly improved its profit margin. Furthermore, the increased influence coefficient of particle size diameter indicates that the market generally places more importance on silver powder particle size, which differs from the preferences of ABC Company's main customers. Therefore, it can be concluded that if ABC Company intends to attract its major customers, it would be wise to continue optimizing the X technology that currently emphasizes the reduction ratio process. However, if the company wants to expand its market share, it should consider incorporating the optimization process for the particle size diameter of silver powder products in its future enhancements to X technology.

**Table 4.7** Results of the impact of X technology on the profit margin of ABC Company

		Coefficient	Standard Error	Standardized Coefficients (β)	t-value	p-value	Coefficient	Standard Error	Standardized Coefficients (β)	t-value	p-value
Before adoption						After adoption					
HB	Burn reduction ratio	0.074	0.011	0.061	3.012	0.033*	0.103	0.014	0.975	3.128	0.029*
	Specific surface area	0.119	0.021	0.103	1.864	0.113	0.101	0.019	0.096	2.316	0.083
	Particle size diameter	0.106	0.015	0.097	2.812	0.041*	0.089	0.026	0.075	3.114	0.032*
QB	Burn reduction ratio	0.094	0.023	0.084	2.553	0.054	0.124	0.019	0.109	3.043	0.041*
	Specific surface area	0.189	0.011	0.172	2.268	0.081	0.107	0.011	0.099	3.096	0.038*
	Particle size diameter	0.091	0.024	0.079	4.817	0.013*	0.134	0.015	0.112	3.101	0.039*
SH-	Burn down ratio	0.096	0.035	0.081	2.251	0.084	0.145	0.019	0.117	3.132	0.028*
QB	Specific surface area	0.185	0.011	0.167	2.547	0.053	0.143	0.016	0.042	3.117	0.031*
	Particle size diameter	0.172	0.014	0.158	0.943	0.413	0.163	0.018	0.371	3.051	0.042*

Note: \* p<0.05



The accelerated evolution of PERC technology has continuously raised new performance requirements for silver powder and slurry. The application of X technology, closely following the current development of PERC technology, can better collaborate with customers and generate more value. As for the customer product system, it has a relatively minor overall impact. Manager Mr. Chen said:

*“The production cost has slightly increased, but compared to the advantages of improved qualification rate, increased sales volume, and increased selling price, it has little impact on the production cost”*

In terms of any changes in customer satisfaction or feedback since the implementation of Technology X, it has been observed that the application of X technology in silver powder products has significantly reduced customer complaints. Since 2023, the return and exchange rate of the product has decreased by 2.39%. However, the return and exchange rate of products delivered using X technology has not decreased and remains at 0.74%. Manager Ms. Li said:

*“Depreciation and qualification rate of raw and auxiliary materials, equipment and facilities”*

And relative person Mr. Chen said:

*“Gradually increasing customer satisfaction and significantly reducing return and exchange rates”*

Furthermore, about any specific improvements or enhancements of silver powder products through the application of X technology, it has been found that they lead to improved quality levels, a stable supply, and a significant reduction in inventory occupation (since the process technology involves confidential information, it is inconvenient to disclose). Ms. Xu, a relevant individual, has mentioned:

*“The test results are stable, with small fluctuations, and a reduced retest rate”*

Besides, implementation person Mr. Wang also said:

*“After the application of X technology, the stability of the production process has been improved, and the product qualification rate has been increased.”*

In terms of any change in ABC Company's market share in the silver powder industry after the adoption of X technology, data obtained from interviews indicates that the application of X technology can provide a broader range of market opportunities. Currently, the newly acquired customers include Wuxi Ruxing and Wuhan Shuomite, among others, resulting in a monthly sales increase of 1000kg and an expansion of market share. For this aspect, manager Mr. Wang explained:

*“In the early stages of implementation, there were increasing uncertainties such as high R&D investment, increased production costs, and long customer validation cycles. However, in the face of the continuous upgrading of PERC technology, Guangzhou Ruxing and other customers worked together with ABC Company to address risks and challenges. The company completed product research and development in a relatively short period of time and passed customer validation, forming large-scale production and sales, becoming another new growth point in the solar photovoltaic field of new materials companies”*

In terms of the application of silver powder in the market, X technology has significantly impacted the competitiveness of ABC Company. Data obtained from interviews revealed that the application of X technology has resulted in improved product quality and performance, optimized production processes, reduced production costs, enhanced production efficiency, increased customer satisfaction, and further expansion of market share. Manager Ms. Li stated:

*“The application of X technology has improved product quality and performance, optimized production processes and reduced production costs, improved production efficiency, and increased customer satisfaction.”*

To better assess the impact of X technology on ABC Company's competitiveness, this section will employ quantitative analysis methods to build a measurement model. By leveraging linear regression techniques, we will use various indicators for silver

powder products, including burn reduction ratio, specific surface area, and particle size diameter, to model the proportion of ABC Company's products within the customer's product system, ABC Company's costs and profits, as well as the market share of its products. The foundational model is as follows:

Considering the availability of data, this paper selected three representative sets of silver powder data from HB, QB, and SH-QB to illustrate the impact of the X process on the quality of silver powder. Based on this, we aim to demonstrate the effect of the X process on the production cost and profit rate of silver powder products. The changes in the quality, production cost, and profit margin of silver powder products after the application of X technology by ABC Company are shown in Table 4.8.

มหาวิทยาลัยราชภัฏธนบุรี

**Table 4.8** Changes in quality, production cost and profit margin of silver powder products after application of X technology by ABC Company

Model number	Before the application of X technology						After adopting Technique X							
	Burn reduction ratio	Specific surface area	Particle size 10 micrometre	Particle size 50 micrometre	Particle size is 90 micrometre	Cost (RMB /g)	Profit margin (%)	Burn reduction ratio	Specific surface area	Particle size 10 micrometre	Particle size 50 micrometre	Particle size is 90 micrometre	Cost (RMB /g)	Profit margin (%)
HB	0.85	1.36	1.19	1.79	3.08	153.69	31.6	0.91	1.26	0.94	1.69	2.74	156.28	32.9
QB	0.89	1.38	1.36	2.58	4.16	162.75	33.5	0.92	1.34	1.27	2.26	3.96	164.13	34.1
SH-QB	0.88	1.48	1.29	2.39	3.62	164.26	32.7	0.91	1.37	1.19	2.27	3.43	169.28	33.8

It can be observed from Table 4.8 that, after the adoption of X technology, the ablation ratio of the three models improves. Additionally, the ratio of specific surface area and different particle size diameters decreases. This suggests that X technology has optimized the three quality indicators in the production process. Specifically, the specific surface area refers to the total surface area of the silver powder material per unit mass. When combined with the reduction of the particle size distribution ratio variable, it implies that the silver powder particles are finer, resulting in a smaller surface area. Consequently, the chemical reactions involving silver powder, used as a raw material in the production process, can occur more completely, leading to an improvement in the final product's performance.

This variable pertains to the percentage of mass loss due to external moisture removal after drying the raw material in the temperature range of 400-600 °C under specific high-temperature conditions. An increase in this variable signifies that X technology effectively removes moisture from silver powder products, resulting in drier silver powder.

Regarding cost and profit margins, although the quality of the three products has improved with the adoption of X technology, the unit cost has increased. This indicates that the current application of the technology is still in its preliminary stage, and cost control needs improvement. Simultaneously, the adoption of this technology has enhanced the profit margin of the three products. This suggests that X technology can significantly increase ABC Company's silver powder's share in the product system of major customers and the overall market share by enhancing the quality of the three types of silver powder. Consequently, it boosts the total sales volume and, subsequently, the profit margin of the silver powder product. In summary, while the introduction of X technology initially raises the average cost of silver powder, with the advancement of production and technology, X technology will continue to lead to further cost reductions and increased profit margins.