

ANALYSIS OF THE DEVELOPING TENDENCY AND STRATEGY OF CHINESE CERAMIC TILE

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1. INTRODUCTION

The developing tendency and strategy of Chinese ceramic tile are influenced and restricted by many factors, such as resources, environmental protection, development of architecture and real estate industry, social economic level and national income, consumption value and aesthetic requirements, scientific level of technical equipment and materials, etc. The influence of craftwork, of equipment and materials on ceramic tile becomes greater and greater, and the restricting effect of resources and environmental protection on the ceramic industry is more and more obvious. This paper makes a simple analysis of the developing tendency of the main Chinese ceramic tile and presents some discussions on the development strategies.

2. ANALYSIS OF THE DEVELOPING TENDENCY OF CERAMIC TILE

Various types of ceramic tile share the following pattern:

- Developing towards the quality of low water absorption rate; glazed floor tile develops from ceramic to stoneware and then to porcelain, and water absorption rate changes as follows: 8%-10%→ 3%-5%→ 1%-3%→ < 0.5%→ < 0.1%; water absorption rate of glazed inner wall tile is constantly lowered as follows: 20%-22%→ 17%-18%→ 15%-16%→ 13%-14%; the aim is to constantly improve the products' performance, prolong the working life and save resources.
- Developing from big specification to small specification in the situation of "polarization"; the specification of the biggest polished tile has reached 1200×2000mm, the specification of ultra-thin tile has reached 1200×3000mm, 1000×2000mm, 1500×3000mm or bigger, and the specification of mosaic products is only 10×10mm or smaller so as to meet the needs for architectural development and people's aesthetic needs.
- Developing from constantly-decreasing thickness; polished tile change as follows: 20mm→ 12mm→ 10mm→ 8mm→ 6mm (different specification); glazed interior-wall tile changes as follows: 10mm→9mm→ 8mm→ 7mm→ 6mm; that of sub-lustrous glazed tile is similar to the above -mentioned that the most advanced 3mm-thick ultra-thin tile has been produced on a large scale so as to save resources (non-metallic mineral resources and fuel) and decrease the weight of buildings.
- Developing towards the quality of high strength; the bending-resistance of polished tile and glazed floor tile is 27MPa→ 37MPa→ 47MPa → 50-60MPa and that of glazed interior-wall tile is 17-18MPa→ 24-28MPa, and the aim is to improve the quality, meet the needs of the architecture industry and lay a good foundation for decreasing the thinness of products.
- To develop in the direction of composite, and ceramic floor tile with surface glazing are changed into glazed porcelain tile (glazed porcelain tile) - the products with the most development potentials. (clay body with surface glaze), porcelain tile and crystal glass composites - crystal glass composite sheet (ceramic and glass composite), general decorative glass and ceramic tile compound - glass ceramic tile, stone and ceramic tile composite - a kind of stone with 2mm of surface, with 8mm of the lower layer, ceramic and metal composite - metal-ceramic tile, plastic and ceramic composite – combination of organic materials and inorganic non-metallic materials (for example: the match between belt line of resin products and basic ceramic tile) ... metal • ceramic • plastic - metal • inorganic non-metallic materials as a composite, which will give full play to advantages, and its purpose is to satisfy people's needs of consumption value and aesthetic needs.
- To develop in the direction of multi-function, the biggest function of general construction ceramic products is to decorate the building space, and is waterproof, fireproof. With the improvement of people's living standards, the requirements on construction and environment constantly rise; ceramic tile develops in the direction of multi-function - easy to clean, self-cleaning, antibacterial, anti-static, infrared, light quality, insulation, thermal insulation,

sound-absorbing, anions, fluorescence, moisture absorption (continuous improvement in wear resistance, non-slip).

- Developing in the direction of diversification on colour, design, convex surface, so as to meet people's aesthetic needs, diversified decorative needs and functional means.
- Supporting the portfolio diversification and integrated development, and design of appearance play an increasingly important role, and the objective is to satisfy the requirements of real estate industry and people's change of consumption value and aesthetic needs.
- To develop in the direction of low-cost, the purpose is to save the world's resources while allowing more people to enjoy these products and improve living quality.
- To develop in the direction of environmental protection, aiming at protecting the environment and necessities such as sunshine, air, water, land and wildlife.

2.1. POLISHED TILE

Polished ceramic tile is an important kind of ceramic product, with great development and production in China. China's production, consumption and export volume of polished tile rank first in the world and China's research & development and production technology is at the leading level in the world!

Polished (ceramic) tile is developed from ordinary glass tile; the series of products are generally under the decorative processing method by the use of different materials, and may be classified into pure colour, small dot, dot large particles, colorants, filled glaze, micro-powder, polycrystalline powder ... such products have a small water absorption rate, general about 0.1%.

The decorative technologies for polished tile are mainly as follows: • the colouring of clay; • combination of different particles (of ceramics, vitrification, organic materials, etc.) and basic materials with different methods (one, two, many times) and modelled by repression • forming the colouring of clay plus colorants (different colours of soluble metal salt) • micro-powder plus colorants • materials arrangement plus colorants.

The main feature of polished tile is to produce highly nature-imitated stone materials (marble, granite, etc.) with smooth polished surface. As there are less and less natural stones (especially precious stones), with many flaws, some being radioactive, such polished tile will have a good sale in the market, especially in China, and be welcomed by the market and accepted by many consumers. However, polished tile has little market share in the international market, with the exception of public works of a small proportion, and there is generally no use or little use in housing.

Currently, the main sizes of polished tile include 300×300, 400×400, 500×500, 600×600, 800×800, 1000×1000, 600×1200, 800×1200, 1200×1200mm, and 1200×2000×20mm is the biggest specification in the world. Restricted by pressing technology, polishing equipment and technology, the specification of polished tile will not develop towards

bigger specification; the main specifications in the domestic market are 600×600mm and 800×800mm, and the main specifications in the international market are 400×400mm, 500×500mm, and 600×600mm.

Polished tile has two main problems to be solved: anti-pollution and anti-skid on the surface. Surface decontamination can be improved by the following methods:

- organic silicon antifouling agent
- nanometre SiO_2 surface treatment
- UV resin antifouling degeneration, regardless of the method, only to improve without a fundamental solution.

Anti-skid is processed only on the surface, either by adding anti-skid agent in the production of clay or by surface coating.

One major problem for polished tile is big loss of raw materials in the production process (grinding technique).

The surface decorative effect of polished tile is comparatively unitary, with smooth stone pattern or pure colour pattern, which limit the decorative effect of polished tile.

Polished tile has the following developing tendency:

- The number of pure-colour tile and coloured-body tile is decreasing, and the products combining translucent feel (albite or glass materials) and micro-powder are increasing.
- The thickness of products starts thinning.
- The products with the combination of material arrangements and colorants are on the rise.
- The products are mainly used for floor and gradually for interior and exterior walls and the proportion is gradually on the rise (to replace glazed interior-wall tile).
- The basic formula system is extended from unitary $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-K}_2\text{O-Na}_2\text{O}$ (feldspar) to a variety of systems, and $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-MgO - K}_2\text{O}$ (talc) has been used.
- The ultra-black polished tile develops from CoO pigment to the use of industrial waste (V-Ti-Ni-Fe).
- The whiteness of super-white polished tile has a constantly rising trend from 40% → 50% → 60% → 70% (of talc) → 80%, and there is a possibility to produce polished tile with 80% whiteness based on materials and production technology.
- Polished tile develops from the opaque type for the special needs of a semi-translucent type, and 0% of transmittance rate can be increased by 40% (occasions of its use are to be discussed).
- The use of translucent material for polished tile has come true, and the application of mica-like materials is yet to be developed.
- The main colours of polished tile include light yellow, white, light grey, and the production and consumption of dark varieties are relatively less. Ultra-white and ultra-white categories of products are gradually rising.

- Polished tile develops towards the direction of non-clay and green pressing and related products are gradually increasing.
- Polished tile develops towards the glazed type; (vitreous) clay is stamped and fused, with a layer of transparent glass on the surface.

2.2. GLAZED INTERIOR-WALL TILE

Due to the unique performance of glazed interior-wall tile, it becomes irreplaceable decorative material on the interior walls of toilet and kitchen and is also an important category of ceramic building products.

- The glazed interior-wall tile has always been mainly white or light-coloured, and in recent years there has been an increase in pure colour and dark colour.
- The designs mainly include stone-imitation pattern, geometric shapes, plant-based patterns, and leather stripes, wall-paper imitation, wood-imitation patterns are gradually increasing.
- The glazed sheen is dominated by touches- (100%) and develops towards the combination of touches (60-70%) and matte (30-40%), and the latter is gradually rising.
- The specification has a developing tendency from small to big, including 100×100mm, 152×152mm, 200×300mm, 250×330mm, 250×400mm, 300×450mm, 300×600mm, 300 (330) ×900mm, 330×1000mm, and 300×450/300×600mm has been the mainstream specification in the market, the proportion of 330× (300) ×900mm is constantly on the rise, 300/330×1000mm is the currently biggest specification for interior wall in the world.
- The zirconium white glaze (including pure-white and stamping) is used more frequently than transparent glaze.
- The products develop from twice-firing to single firing. Small output (<6000m²/d) should be under single firing and large output (> 10000 m²/d) should be under twice-firing.
- The water absorption rate changes from higher (20-22%) to lower (13-15%).
- The thickness changes from thicker (10mm) to thinner (6mm).
- The clay composition changes from "clay - quartz - limestone" (SiO₂-Al₂O₃-CaO-K₂O) to "clay - quartz - wollastonite (diopside)" (SiO₂-Al₂O₃-CaO-MgO), with declined moisture absorption and longer working life.
- The firing shrinkage rate changes from bigger (about 3%) to "zero shrinkage".
- The intensity changes from smaller (≥ 17 MPa) to bigger (28MPa).
- The printing techniques have upgraded from flat screen printing to rubber roll printing, with richer transitional designs (160-180 types → 325 types), and with more natural changes.

- The use changes from complete adhesion to the combination of shock wave, belt line and floor tile, and the proportion of slotting and cutting is on the rise.
- To guarantee the adhered effect of finished products, “side grinding” is increasing, generally the specification of 100×100mm, 152×152mm and 200×300mm will not be ground, and grinding techniques are adopted for the specification of 300×450mm, 300×500mm and 300×600mm or bigger specification, with the development from the wet method to the semi-dry method.
- The tile changes from the functions of interior decoration, waterproof and fireproof to the functions of easy-cleaning, self-cleaning, anti-bacterial, anions, far infrared.
- The products reform from the “bottom permeability / non-watertight” to “bottom non-permeability / impermeable” the technology makeup soil (end glaze) advances quickly.
- The production, sale, quantity of use have a rising trend.

2.3. GLAZED PORCELAIN TILE

Glazed porcelain tile has many names: Matte brick, glazed porcelain tile, glaze tile, Yaguang tile, antique tile, classical tile, the Pan-aged tile..., but no matter how it is named, it actually refers to the product whose water absorption rate $<0.5\%$ with surface glaze, and which is matte (7% -35% polish) and the colour of the body is similar to that of the glaze).

Glazed porcelain tile originates from glazed floor tile and the obvious distinction lies in water absorption rate as $13-14\% \rightarrow 8-10\% \rightarrow 3-5\% \rightarrow 1-3\% \rightarrow 0.5-1\% \rightarrow 0.1-0.5\% \rightarrow 0.1\%$. With the change of water absorption rate from higher to lower, the product changes from ceramic to stoneware and then to glaze.

Glazed porcelain tile is the mainstream product in the market of Europe and the United States. It can be said that they are developed from polished tile/ wear-resistant tile. When wear-resistant tile (pure-colour or spot colour) is treated by matte glaze with many times of printing, they become glazed porcelain tile.

In recent years, glazed porcelain tile has developed rapidly in China and become one of the most promising products; such slabs can not only be installed on floors, but also adhered on interior and exterior walls. In more and more places, they can replace polished tile and glazed interior-wall tile, thus they are widely used in the real estate industry.

Glazed porcelain tile is generally completed by single firing at a temperature of $1190-1210^{\circ}\text{C}$ and the cycle of 45-60min; the main specifications include: 300×300mm, 400×400mm, 500×500mm, 600×600mm, 300×600mm, 800×800mm, 900×900mm, 600×1200mm, etc. and the international market mainly adopts the specifications of 400×400mm and 500×500mm, and domestic market mainly adopts the specifications of 600×600mm and 800×800mm; the specification of 300×600mm is popular both at

home and abroad; the specification of 600×1200mm is one of the developing tendencies of glazed porcelain tile.

Glazed porcelain tile includes the flat type and convex surface type, but both are produced by milling process, the specification of 500 × 500mm abroad does not need side-milling, but all the Chinese glazed porcelain tile requires the milling techniques.

Glazed porcelain tile mainly includes the colours grey, yellow, coffee, red brown, greyish dark with diversified decorative practices, and a combination of plate printing and rubber roll printing, spray enamel and stain glaze, milled glaze and non-milled glaze, flat and convex surface, and featured by various kinds of flashing dry tablets, colour frit, dry toner, metal glaze so as to make the surface diversified.

The designs of glazed porcelain tile are mainly wood imitation, stone imitation, and leaves imitation, and also leather-like, wool-like, cloth-like, wallpaper imitation, carpet-like, metal-like, bamboo-like ... and so on, its manifestations are diversified, and basically various forms in nature can be represented on glazed porcelain tile and the finished tile can be semi-LAPPATO or non-LAPPATO and has two glazed surfaces. So far, the decorative means and representing forms of glazed porcelain tile are the richest in all.

The main developing tendency of glazed porcelain tile in recent years is as follows:

- The size and specification have an increasing trend, with continuous improvement in technology for wear-resistance and flatness.
- The proportion of metal glaze, stamped metal enamel and semi-LAPPATO is on the rise.
- The proportion of surface effects rises.
- The application of dry glazing process increases.
- The proportion of rubber roll printed tile rises, particularly export products.
- The combination of flat printing and rubber roll printing and an increase of jumped printing.
- Rubber roll matte transparent glaze should be adopted in the latest time or frit tablets with rejection glazing, and later firing semi- LAPPATO later; the proportion of such products is on the rise.
- By maintaining “stone” design as the main, products with the effect of “wood imitation” increase significantly.
- The proportion of integrated installing and adhering of tile is obviously on the rise and constantly replaces polished tile and interior-wall tile.
- The proportion of embossing stone products by the use of “inkjet” printing technology (Ink-CID/Kera-jet) rises.
- The proportion of leather strips is on the rise.

- The proportion of pure-colour or spot colour glass clay with rubber roll printing (twice to three times) and matte transparent glaze is also on the rise. (decoration directly on the green clay)
- The research and development, production, sale, use have the rising trend.

2.4. EXTERIOR-WALL TILE

The ceramic tile is divided into the glazed and unglazed types; “the glazed” is generally with matte glaze; currently bright glaze is not used for exterior wall (except under special design requirements), “the unglazed” is generally “wholly glassy” stone. Water absorption rate of exterior wall decreased significantly in recent years, from 7-8% to 3-5%, then 1 - 3%, and most of the existing production is ceramic wall tile with water absorption rate <1% (The merits are long working life and good frost resistance performance)

Influenced by urban construction, safety of high buildings and self-weight, the specification gradually decreases from 100×200mm, 60×240mm, 95×95mm, 100×100mm to 45×45mm, 45×95mm, 33×75mm and they constantly thin.

The main colour for exterior-wall tile is light-coloured (light yellow, light grey, white, etc.) and general design of whole-body exterior wall is under foveola stone-imitation and glazed tile mainly has the effect of coating imitation.

External walls have many kinds of decorative materials: coated glass, aluminium-plastic plate, stone, glass mosaics, polished tile, glazed porcelain tile, paint, etc., and the competition of ceramic exterior-wall tile is very fierce, and the quantity of use has a trend of decline.

The developing tendency in recent years is as follows:

- The decoration of surface is artistic, and special effects require vinyl glazing, metallic glaze, pearlescent glaze, variable-colour glaze, and so on.
- Functional-except basic functions of decoration, fireproof and waterproof, the functions include easy cleaning, self-cleaning, light quality, and thermal insulation, etc.
- Scale production, centralized manufacturers and decreased factories.
- Water absorption rate is reduced to below 1%, developed towards ceramic products.
- The specification reduces and the tile gets thin.
- The quantity of use of glazed products increases. (better decontamination)
- The proportion of adopting 600 × 1200mm spec of glazed porcelain tile on lower floors of large buildings is on the rise.
- The overall production and sale show a declining trend.

2.5. SEVERAL OTHER CERAMIC PRODUCTS

2.5.1. *Plaza stone*

- A decrease of manufacturers and a decline of use. (Main shortcomings: unitary decorative style, impermeable)
- Threatened by the competition of by stone materials, wear-resistant tile (ordinary), small specification of embossed glazed porcelain tile.
- The use of industrial waste, with increased proportion of mine tailings.
- The specification are restricted, generally middle and small, such as 100×100, 200×200, 150×150, 300×500, 250×400, 350×600, 500×500mm.
- Mainly the natural granite-like (spot effect) and unitary decorative effect.
- The proportion of producing by dry colour mixing is on the rise.
- Gradually to the development of environment-friendly plaza tile- the use of production wastes of glass tile, industrial slag, tailings-based raw materials, products with the performance of water preservation and treatment, but the products have high cost, threatened by fierce competition from cement products and the output is hard to increase.

2.5.2. *Ceramic split tile*

Because of the difference of its forming process from ordinary tile in “semi-pressure moulding”, the products are modelled in the semi-wet approach (18% moisture content or lower), thus discussed separately.

- Mainly for use in exterior walls, in addition to floor.
- Few manufacturers and little quantity of output and use.
- The unique colour (for example: red), and other products are difficult to replace it.
- The unique “graining” (for example: “Graining tile” produced by Shiwanmei Pottery Factory), and there is still some attraction in the market.
- The unique design of back lines “dovetail groove”, firmly adhered external walls and floor tile.
- The developing tendency: artistic surface, being glazed, reduction of moulding moisture, diversification of specification.
- The future output will not have a significant growth, maintaining a small market share.

2.5.3. Ceramic-glass tile

- Few manufacturers, high cost (lower than wholly glass sheet), low rate of excellence, difficult production technology.
- Mainly in twice-firing and the single firing technology is not mature enough.
- In a light-coloured (white, cream, light grey), limited sale of dark products.
- The use of $\text{CaO-Al}_2\text{O}_3\text{-SiO}_2\text{-ZnO}$ system, ZnO's prices rose greatly in recent two years, which has a very great impact on the cost of glass materials, so it is necessary to initiate the development of $\text{CaO-MgO-SiO}_2\text{-Al}_2\text{O}_3$ series.
- The main specification should be $\text{CP} \times 600 \times 800\text{mm}$ and the specification in the future will not be increased.
- The time for crystallization (firing) is short (usually less than 3 hours), wollastonite crystal (CaO-SiO_2) will be premature, the products have imperfect wear resistance and are easy to be worn out or lose polish.
- Mainly used for interior and exterior walls, in addition to the use on floor.
- The developing tendency: research and development of new prescription system to improve crystallization, surface wear-resistance, composite of glass sheet and clay of glass tile to reduce cost. Self-cleaning function of glass-ceramic tile is used on the exterior walls.
- The market sale has a trend of decline.

2.5.4. Transparent glazed floor tile

The water absorption rate is 7-8%, mainly in red clay, with many times' use of makeup soil and surface glaze printing, which is high-polishing transparent glaze. Characteristics: cheap, bright surface; Fatal flaws: bad surface wear-resistance and poor anti-slip performance.

This kind of products is destined to be transitional products and their developing tendency includes:

- Glazed surface changes from touches to matte.
- The water absorption rate reduces to 3-5% and $<1\%$.
- The crystal slabs change into glazed porcelain tile.
- The crystal slabs change into a "glazed tile" –"ceramic glazed tile" is the kind of products with the most potential, combining the merits of both polished tile and glazed porcelain tile.
- The ceramic glazed tile - glazing, printing and adding a layer of touches glaze on the green clay, with firing and soft LAPPATO; generally with minor bump effect, transparent and crystal surface for interior decoration and

luxurious show, and the main specification include 500×500mm, 400×400mm, 600×600mm, 300×300mm.

2.5.5. Ceramic mosaic tile

Ceramic mosaic tile is divided into glazed ceramic mosaic tile and unglazed mosaic tile. As the surface of unglazed products absorbs dirt easily and is hard to clean, their manufacturers and output obviously decrease.

Ceramic glazed mosaic tile is mainly in the square specification of 25×25mm and complementarily in the round specification of 45×45mm; the water absorption rate is generally <1% (porcelain) and ceramic glazed mosaic tile has the following development pattern:

- Diversified specification, varieties and composites.
- Combination of pure colour and gradually-changed colours.
- Combination of touches and matte.
- Combination of varieties of glaze, such as crystallization, pearl light, kiln variety, colourfulness, metal.....
- The increase of combining glazed interior-wall tile mainly for toilet and bathroom.
- The gross volume of market is not big but will gradually rise.
- The demand of export is not big and domestic market share is small.
- A large proportion of individualized design.
- The proportion of ceramic mosaic used for swimming pools is on the rise.

2.5.6. Tile made by hand

- Mainly in middle and small specification such as 75×75, 100×100, 150×150, 200×200, 300×300mm, with clay made by hand to pursue the feel of nature and simplicity.
- The use of glaze with artistic effect, each one is under different pursuit for personality.
- The independent application or combination of matte tile and glazed interior-wall tile.
- High added value, small output and dense cultural atmosphere.
- The market capacity is not big but will gradually increase.

3. QUALITATIVE ANALYSIS OF THE MARKET OF VARIOUS KINDS OF CERAMIC TILE

Serial number	Name	Market capacity	Domestic market	Foreign market	Forecast of developing tendency
1	polished tile	big	big	small	Slowly decline
2	glazed interior-wall tile	big	big	big	Slowly rise
3	glazed porcelain tile	big	small	big	Rapidly rise
4	glazed exterior-wall tile	medium	medium	small	Decline
5	plaza stone	medium	medium	small	Decline
6	ceramic split tile	small	small	small	Remains table
7	ceramic glass composite tile	small	small	small	Decline
8	crystal tile	medium	medium	/	Obviously decline
9	ceramic mosaic tile	small	small	medium	Slowly rise
10	tile made by hand	small	small	small	Slowly rise

Table 1.

According to initial forecast, the main products in the market are polished tile, glazed interior-wall tile, glazed porcelain tile, glazed exterior-wall tile, which have a big market share. Some individualized products (ceramic split tile, ceramic mosaic tile, tile made by hand) have a small market share but will increase slowly.

In the future market of ceramic products, polished tile, glazed exterior-wall tile, plaza stones, crystal tile and ceramic-glass tile will have a trend of decline, being different in speed.

As glazed interior-wall tile used in the bathroom, kitchen are difficult to be completely replaced, its market demand will be stable and rise, but will also face the competition from glazed porcelain tile and polished tile.

Glazed porcelain tile has the most potential and the fastest rise and will not “crack” when used for decorating interior and exterior walls.

4. SOME DISCUSSIONS ON THE DEVELOPMENT STRATEGY FOR CERAMIC TILE

According to the analysis of the developing tendency of various kinds of ceramic tile, we can find the following pattern:

- Glazed tile is on the rise while unglazed tile declines.
- The products with high water absorption rate decline and those of low water absorption are on the rise.
- The matte tile increases, and glossy tile decreases.
- The products with middle and small specification are on the rise and those of small specification decline.
- Multifunctional products increase slightly and thin tile is on the rise.

Serial number	Production region	Main production	Remark (output)
1	Guangdong	polished tile, glazed interior-wall tile, glazed porcelain tile, glazed exterior-wall tile, mosaic, ceramic glass composite tile, etc.	No. 1 Production Region
2	Shandong	glazed interior-wall tile, polished tile	No. 2 Production Region
3	Sichuan	crystal tile, glazed interior-wall tile	No. 3 Production Region
4	Fujian	glazed exterior-wall tile, glazed interior-wall tile	No. 4 Production Region
5	Eastern China	glazed interior-wall tile, polished tile, ceramic glass composite tile, etc.	No. 5 Production Region
6	North-eastern China	No major products	/
7	North-western China	No major products	/

Table 2. Distribution of ceramic tile in various production regions of China

- China's main production regions include Guangdong, Shandong, Eastern China, Fujian, Sichuan, and the North-eastern China develop rapidly in recent three years but the development in North-western China is still slow. Guangdong Production Region has a rich variety of products. Energy consumption and raw materials of a variety of products (according to statistics).
- The output of varieties is unknown (no statistics).
- The quality of ceramic products in various production regions is varied; generally the quality of products in Guangdong and Eastern China is high, while the cost of products in Shandong, Fujian, and Sichuan is low (due to raw materials, fuel and so on).
- In regard to the quality of products, quality of the majority of the Chinese ceramic products is similar to that of products from Italy and Spain, but the stability of production is weak and there is a low degree of automation.
- Reflected in many ways, the level of industrial design of Chinese ceramic products is still low and many manufacturers lack originality of products, they indulge in plagiarism and imitate; the protection of intellectual property rights for the appearance design is inadequate and self-discipline in the industry has not yet been formed.
- The Chinese ceramic products' support level is still unsatisfactory, and integrated design has just begun.
- The price of Chinese ceramic products in the international market is also very low, and unit price is 1 / 3 to 1 / 4 (around 1 / 2 for good products) of Italy.
- The Chinese ceramic products have a great output, but weak competitive force in the international market. The output of Chinese ceramic products in 2006 is about 3.5 ~ 4 billion m², about 10% of which is exported. According to the population of 1.3 billion, China's current consumption per capita is about 2.43 to 2.77 m². (another figure in 2006 is about 5 billion and the export is about

500 million m², 4.5 billion m² sold in the domestic market, the consumption per capita consumption is 3.46 m²).

- The energy consumption and non-metallic mineral for Chinese ceramic products are great, (the consumption of raw materials for ceramic tile is about 20kg / m², with fuel consumption of 1.3 litres/m², 1.6 degrees/m² of power consumption); the production process has a great impact on the environment, far from the standards for clean production.
- The packing of Chinese ceramic products does not belong to the type for environmental protection and no degradable white foam is also in the packing at a large quantity. Subject to various constraints, and their own shortcomings, the strategies for the development of Chinese ceramic products are as follows:
- Strengthening industrial design of ceramic products, for progressive realization of the transfer from centring on techniques and equipment to centring on design and application; to strengthen the introduction of designing talents; powerful ceramic enterprises should establish design centres for products, and create the conditions to cooperate with related Italian design groups and enterprises and the establishment of design centre.
- Under the condition of mutual benefit and common development, create the conditions to make Foshan, Zibo as China's main production regions friendly cities of Italy's Sassuolo and Spanish Castellón.
- The industrial associations (China Ceramic Industry Association/China Ceramic Industry Association) should take the lead to organize as early as possible Ceramic Product Design Professional Committee, hold an annual design competition of ceramic original products, so as to form a kind of good style with a respect for the original and offer incentives for good corporations and individuals.
- R&D and production of various ceramic products are made in recent years, but the naming of products has a lack of scientific nature. Industrial associations should organize related enterprises, research institutes, and universities and colleges to make discussions and make related rules and regulations.
- The industry association will organize relevant enterprises and units for standardization, computation and inspection to make amendments on the systematic standards of current ceramic products.
- To save energy and raw materials, enterprises should be encouraged to thin the products and guarantee quality, the industry association makes products standard for market promotion and application.
- Strengthening the match and supporting integrated design of ceramic products to enhance the added value of products.
- In the production process of ceramic products, promote clean production as soon as possible to reduce the impact on the environment, improve packaging materials and design, promote "green" packaging for environmental protection.
- Support and encourage the expansion and export of ceramic tile and develop the international market at a reasonable price.

- The entire industry will promote the use of light-quality raw materials for the production of ceramic products, and the government will provide preference policies such as tax reduction to ceramic enterprises producing with industrial waste and light-quality raw materials.
- Viewed from the global trend of ceramic products, China should continue to maintain a leading edge technology and meanwhile control the production and consumption quantity of polished tile (this kind of products have a great consumption of raw materials and fuel and generate large quantity of waste materials), to promote stoneware/ceramic matte tile with water absorption rate $<0.5\%$; and the water absorption rate of $1-3\%$ should be popularized; to increase the output of semi- LAPPATO matte tile.
- To complete self-making of domestic glazing equipment and dry powder and promote the technology and products with one year.
- To complete technological industrialization of equipment for domestic ultra-thin plate within two to three years and further perfect and popularize new system of polished tile.
- Follow the latest printing technology for ceramic products (inkjet printing technology); conditional machinery manufacturers are suggested to cooperate with research institutes and develop domestic equipment and technology as early as possible.
- Support the research and development of water-preservation plaza stone.
- Carry out the research and development of “ultra- white and semi-permeable” (whiteness of $>80\%$ transmission $>30\%$) and application projects.
- Carry out the research and development of multi-functional ceramic tile to enhance people’s added value. (Self-cleaning, ceramic-glass exterior wall tile, solar tile, etc.).
- Support the industrialization and application of light-quality heat preservation projects.
- The entire industry should transfer from the heightening of output to quality and design and control excessively rapid increase of output.
- The production of ceramic products consumes a large quantity of energy and resources; the industry of ceramic tile is not supportive industry of the Chinese industry; the entire industry should take action soon, decrease the consumption of energy and resources and popularize various kinds of energy-saving technology.
- Actively support the development of ceramic tile in the Northeast and Northwest, lower the transport cost and realize rational distribution of domestic ceramic products.
- Encourage the transfer of ceramic enterprises from city and village, from developed coastal areas to middle part, Western part and North-eastern part and realize rational resources setup.

5. CONCLUSION

In the coming five to ten years, types of China's ceramic tile will be diversified and quality will be heightened and the proportion of originality rise, the level of automation industry will be heightened; with great heightening of added value and decreased consumption of resources, the products are to be popular all over the world, China's ceramic industry will develop more healthily!