

Investment Casting Market Review

Chinese Mainland

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■ Investment casting technologies in Chinese Mainland

Processes

Casting

Category I

(Colloidal Silica Shell Process)



high value-added casting

general commercial casting

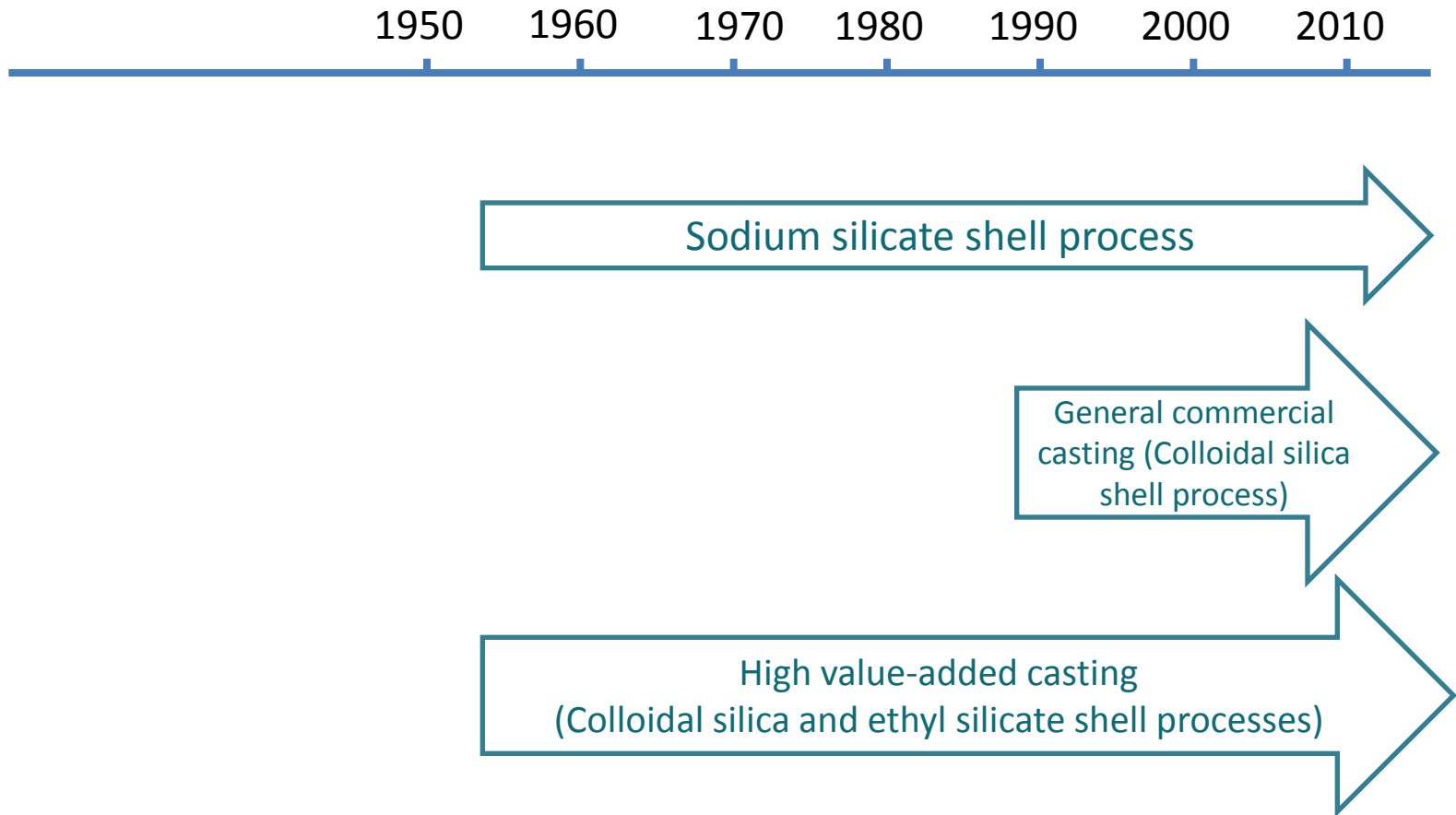
Category II

(Sodium Silicate Shell Process)



low-cost casting

■ History of different technologies in Chinese Mainland



■ Current situation of different technologies

◆ Sodium silicate shell process

- Introduced from the former Soviet Union in the middle of the last century

Pattern material: paraffin-stearic acid

Shell binder: sodium silicate

Shell hardener: Aqueous solution of NH_4Cl , AlCl_3 or MgCl_2

- Main product
 - carbon steel, low alloy steel, nodular cast iron castings for camions, motorcycles, farming machines, engineering machines, valves, pumps, etc.
- Number of foundries: > 1000
- Output : > 1 million tons per year
- Main market: domestic and overseas

■ Current situation of different technologies

◆ General commercial casting (Colloidal silica shell process)

- Main product
automobile, pump, valve, hardware, tool, sport goods, etc.
- Main materials
stainless steel, carbon steel, etc.
- Number of foundries: ~600
- 2015 output value: \$1.87 billion (-10% v 2014)
- Main market: overseas

◆ General commercial casting (Colloidal silica shell process)

The foundries continue getting technological progress and become more proficient after the development of more than 25 years.

Some companies have had their equipment upgraded, especially the wax injector, wax treatment and delivery system and shell building line.

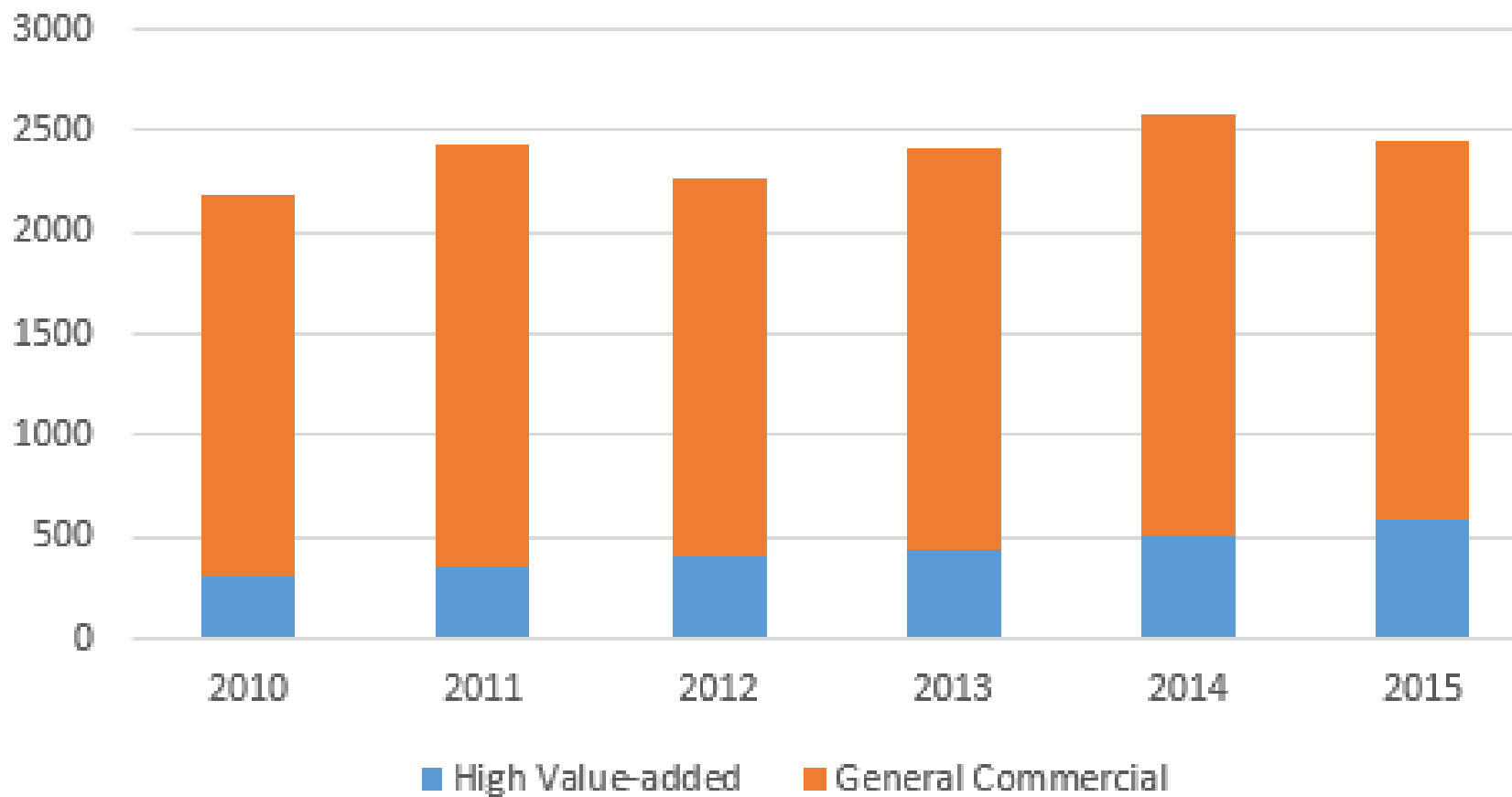
Domestic supply system of raw material and auxiliary materials and equipment has been formed in Chinese Mainland.

■ Current situation of different technologies

◆ High value-added casting (Colloidal silica shell process)

- Main product
aerospace, military, IGT, turbocharger, etc.
- Main materials
super-alloy, titanium alloy, aluminum alloy, etc.
- Number of foundries: ~60
- 2015 output value: \$0.58 billion (+15% v 2014)
- Main market: domestic

US\$M



■ Development trend

◆ Environmental protection and energy saving

Foundry Industry Access Conditions was released by China Government on May 10, 2013

The scale of output value, casting quality control, environmental protection, energy consumption are set as permitting threshold for foundries.

◆ Reduce manual operation

Higher labour cost (+10% to 15% per year in recent years)

◆ Enhance the R&D and manufacturing ability of high value-added castings for domestic market

Aviation - Civil

- China will Become the largest aviation market in 10 years (predicted by Airbus)
- China's first home-grown regional jet, ARJ21-700 has get the airworthiness certificate and finished the first delivery to the airline in 2015
- Large trunk liner C919 has come off the assemble line on November 2nd, 2015
- Aero-engines for civil aircraft are imported from oversea suppliers now and part will from domestic suppliers in the future

- ◆ Enhance the R&D and manufacturing ability of high value-added castings for domestic market

Aviation - Military

- Early in the 1950s, investment casting process was introduced for military aircraft engine industry in the Chinese Mainland
- Whole military aircraft manufacturing system has founded and develops quickly in recent years
- An huge and integrated aero-engine manufacturing company will be founded soon after aviation industry restructuring in Chinese Mainland

◆ Enhance the R&D and manufacturing ability of high value-added castings for domestic market

IGT

- The government has put the gas turbine and aero-engine as a major strategy in the development of manufacturing industry
- Several private capital companies have participated in building new advanced foundries aimed at investment castings for IGT

Summary

- General commercial casting suppliers become stronger and are also facing more challenges
- Technologies and facilities help to environmental protection and energy saving are welcome
- Robot and other equipment are developed to reduce labor
- Domestic aviation industry continue to grow and stimulate the improvement of investment casting R&D
- Aero-engine and IGT are being highly concerned and supported by the government