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# 2008 Annual Report on Germanium Market 1 Properties, usages, distributions of germanium

* 1. **Germanium properties**

Germanium is a silvery-gray, brittle metal, albeit some people also calling it a semi-metal, which has a bright luster. It was discovered in 1886 by a Germany chemist. Its melting point is at 937.4"C, boiling point at 2830"C and density around 5.35g/cm3•

Germanium is contained with zinc ores, other sulfide ore minerals and coals. The average germanium content in zinc deposits from which it is recovered ranges from 0.01% to 0.1%, while that in coals differs from 0.001% to 0.1%.

# Germanium usages

Germanium used in fiber-optic systems accounts for 24% of the worldwide consumption, polymerization catalysts, 31%; infrared optics, 23%; solar electric applications, 12%; and others (phosphors, metallurgy and chemotherapy), 10%.

However, the situation differs with countries. For example, Japan uses germanium mainly as the polymerization catalysts, while such applications are rare in America, where germanium is mainly consumed in fiber-optic systems (40% of the American consumption), infrared optics (30%) and solar cell applications (20%).

Worldwide germanium consumptions

Solar cells 12%

Fiber optics

24%

Infrared optics 23%

PET catalysts

31%

# Germanium distributions in China

China has a reserve base of 3,055t of germanium, which is spread in eleven provinces and regions, including Guangdong, Yunnan, Jilin, Shanxi, Sichuan, Guangxi and Guizhou

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provinces. Germanium reserves in the above provinces take an account of 96% in the total amount.

# Market Review

With global economic crisis spreading across the world from the fourth quarter of 2008, both producers and consumers hold a wait-and-see attitude towards the germanium market. Except for some long-term contracts having been signed before, new orders are seldom sealed. Few inquiries in the market and panic sentiments from participants cause the price to go down, which makes consumers continue to watch the market, which explains why there were few deals in the fourth quarter. The germanium market was deadlocked in December 2008, and the price trend may be clear next year.

# Germanium metal market review



China germanium metal export price -.- Germanium metal price in Europe Germanium metal price in China

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CSource: Asian Metal)

China germanium metal price was relatively stable in the first quarter in 2008 and it rose slightly in March. Germanium metal export price keeps stable at around USD1,300-1,320/kg from January to February, but went up to around USD1,380-1,400/kg late March as some Chinese suppliers increased offers.

Germanium metal price kept rising in the second quarter, eventually up to around USD1,600-1,620/kg in May. The main reasons for the continuous price increase were the tight supply in the market and Chinese suppliers continuing to increase their offers. However, the price remained stable in June, rather than continuously going up, because some zinc producers started to sell germanium dioxide inventories when zinc price began to drop, which helped ease up the supply shortage.

The price began to fall from USD1,600-1,620/kg to USD1,580-1,600/kg in the third quarter, with the offers widely-ranged. Some suppliers even offered as low as USD1,500/kg, since

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few deals were concluded in the market during the summer holiday in western countries. The market remained inactive in September, when foreign consumers finished their summer vacation and the export price fell to around USD1,560-1,580/kg.

Few deals were concluded in germanium metal market in the fourth quarter, and the price declined considerably in October and November from USD1,560-1,580/kg to USD1,330-1,350/kg, down by around 15%. The price stayed at the above level in December, and consumers ere holding a wait-and-see attitude while producers were reluctant to lower offers, making the market stagnant.

* 1. **Germanium oxide market review**



Germanium oxide price cunes in 2008

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China germanium oxide export price -+- China germanium oxide price

(Source: Asian Metal)

Chinese government started to impose 5% export duty on germanium oxide (HS Code: 28256000) from 1st Jan 2008, so Chinese exporters raised offers from USD870-890/kg to USD930-950/kg at the beginning of January, and kept increasing it to around USD1,030-1,050/kg during April and May though Japanese consumers were unwilling to make purchases at thess high prices.

However, there was increasing germanium oxide supply in the spot market in June. Some Zinc producers were forced to sell germanium oxide inventories as zinc price kept falling, so the supply of germanium oxide began to increase and the price increase of germanium dioxide slowed down. The price of zinc 99.995% min was around at the beginning of January, 2008, and from then on it kept dropping and declined to around RMB16,000-16,100/t late May, down by 16% in a period of five months. Some zinc producers increased the sales volume of germanium oxide to make up the losses.

Germanium oxide price began to fall from USD1, 030-1,050/kg in July, and then, affected by the economic crisis, it dropped to around USDS00-820/kg in the middle of November, remaining stable in December as Chinese suppliers were reluctant to lower offers, leaving the market in a stagnant situation.

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1. **Production situation in China**

Unit" tons

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| Products | 03 outputs | 04 outputs | Total outputs in 2008 |
| Germanium oxide | **10.1** | **9.4** | 36.2 |
| Germanium metal | 10.9 | **8.8** | **37.7** |
| Germanium nomocrystalline | **3.4[R]** | **3.4** | **12.4** |

(Notes: Germanium oxide output have been converted to germanium metal volumes; R means that the date has been revised.)

China produced 86.3 tons of germanium products in 2008, but consumers chose to watch the market in the fourth quarter due to the economic crisis, without too many purchases in the spot market, so germanium oxide output decreased in the fourth quarter.

1. **Germanium applications**
   1. **Germanium oxide used as a catalyst in producing PET bottles**

Germanium oxide, used as a PET catalyst, is mainly exported to Japan. It is reported that Japanese customers may use antimony trioxide instead of germanium oxide. However, Chinese insiders think that the replacement cannot be achieved in a short time as antimony trioxide catalyst could release hazardous substances when heated.

* 1. **Germanic tetrachloride used** in **fiber-optic communication**

Fiber-optic communication is the foundation of the information age. Optical grade germanium tetrachloride (i.e., high purity germanium tetrachloride) had been developed since 1973 in order to meet the need of fiber-optic production. Germanium used in fiber-optic communication mainly serves as fiber-optic and photoelectric conversion. As the operating wavelength of fiber-optic communication should be within the infrared range, germanium-doped silica fiber is regarded to be the best when considering the performance (refractive index, coefficients of expansion) after the research of all other extra-long wave infrared fiber-optic materials. In terms of performance parameters, such as loss coefficients, the superiority of the germanium-doped silica fiber cannot be matched. Germanium tetrachloride is considered to be the best materials used in fiber-optic communication.

With the copper price rising while optical fiber price dropping, optical fiber cable has an incomparable advantage compared with copper cable in the aspect of transmission speed and transmission capability, so it may be a new substitute, which will bring great opportunities for optical fiber cable industry.

* 1. **Germanium metal used in infrared optical sector**

Germanium metal is wildly used in infrared optical sector, mainly applied to national

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defense equipments. The atmospheric transmissivity of germanium is high and homogeneous because it is within the 2~14 micron infrared band where the infrared ray has the highest transparency in the aerosphere. Therefore, it is an irreplaceable infrared optical material. Meanwhile, germanium has lots of prominent dominance, such as chemical stability, corrosion-resistant and easily processed. Germanium could be made into germanium single crystal, and sliced up to make germanium lens and germanium windows. Germanium single crystal could be made into infrared optical components because of the characteristic of tong wavelength when permeating infrared optical, which is wildly used in all kinds of infrared optical system, such as thermal infrared imager and night-vision goggles, photo detector, infrared detectors, missiles, lasers, infrared radar microwave tubes and microwave integrated circuits.

In the aspect of germanium used in national defense equipments, the demand for germanium depends on the update of national defense equipment, and may increase with the update term arriving.

* 1. **Germanium single crystal used in solar cell industry**

With the unique trait of high radioresistance, high frequency, good photoelectric properties, high purity germanium single crystal is wildly used in the high-tech fields, such as energy sources, photoelectricity, national defense, aviation and IT industry. Compound semiconductors on germanium substrate battery with its trait of high efficiency, high voltage, and high temperature has been wildly used in satellite solar cell, radar station for national defense in remote and border areas and microwave communication stations.

After Si, GaAs, lnP solar battery, lll-V compound thin-film epitaxially grown on germanium substrate solar cells (namely (GalnP/GaAs/Ge) monocrystalline thin-film three-junction solar cell} is the fourth generation product whose highest photoelectric conversion efficiency could achieve 28%-32% under industrialization, and the germanium monocrystalline with dislocation density {S103/cm2) is the major substrate material to produce satellite solar cell. It is reported that with the development of photoelectric conversion efficiency of germanium monocrystalline used in solar battery, solar energy photovoltaic field becomes another growing market where germanium could be applied to.

* 1. **Germanium used in new technology fields**

SiGe compound has been applied to CMOS chips and transistors because it makes CMOS chips and transistors smaller, reduces electronic noise produced by themselves, extends battery life, and assures stability under the extra HF condition. IBM has announced that they have produced SiGe chips operating at room temperature with frequency nearly 350GHz. In the areas of wireless communication, we have substituted SiGe compound for GaAs; Si chips producers have produced low cost and industrialized SiGe chips. Scientists are now doing research into the germanium insulating substrate material which can replace silicon metal in a small chips and LED products based on germanium.

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AgGe alloy contains about 1.2% germanium, and any blots appearing on the surface of the alloy can be easily wiped with wet sponge. AgGe alloy with high hardness and strong crumpling resistance can be used to make large-scale silver ware, special castings and gold solder during the process of jewel and jade. PtGe halide can be used as catalyst during the process of petroleum refining, and PtGe alloy can acted as cracking catalyst.

1. **Analyses of germanium products imports and exports statistics analysis**
   1. **Analysis of China germanium metal exports statistics**

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(Source: China Customs)

China exported 48,146 kilos of germanium in 2008, 10% down compared with that in 2007. The export volumes dropped sharply since October 2008, down by around 46%, 50% and 74% respectively in October, November and December 2008, compared with the same period in 2007, because economic crisis broke out in October, and most consumers held a wait-and-see attitude in August and September due to falling price.





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China gennanium metal export vulumes by country in 2007 and 2008

(Source: China Customs)

Chinese germanium metal were mainly exported to Germany in 2008, accounting for 40% of the total export volumes, next came America and Belgium, respectively around 20% and 15%. China's export volume to Germany was down by around 12% in 2008 compared with that in 2007, down 4% to Belgium, but up 78% to America.

# Analysis of Japan germanium products custom statistics

* + 1. **Analysis of Japan germanium oxide import statistics**

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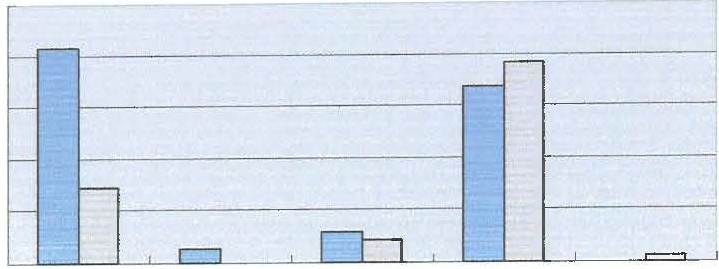
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(Source: Japan Customs)

Japan imported 29,207 kilos of germanium oxide from January to November in 2008, 30% down compared with that in 2007. The price dropped further after Chinese government started to impose export tax, but the purchasing quantities decreased as Japanese consumers were reluctant to make purchases at higher prices.



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(Source: Japan Customs)

Japanese gennanium dioJCide e.xportvolumes bycountryin Jan-Nov 2007 and2008

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Japan reduced the purchasing quantities from China to only 7,229 kilos of germanium oxide in Jan-Nov, 2008, down by around 65% compared with that in the same period in 2007. Germanium oxide imported from Canada was up by around13%. Moreover, Japan purchased materials from America in 2008, instead of Finland.

# Analysis of Japan germanium metal import statistics

Japanese gennaniurn metal import 1..0lurnes by month in 2008

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( Source, Japan Customs)

Japan imported 6,072 kilos of germanium metal from January to November in 2008, with the import volumes from China and America accounting for 89% and 9% respectively of Japan's total import volume. Organic germanium and germanium accessories were very popular in Japan in 2005 and 2006, but not so prevailing recently; the demand for germanium oxide from solar battery may increase, and now Japanese Fuji Electric Systems Co., Ltd is doing researching into SiGe non-crystal film solar cell.





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# 6Market forecast

* 1. **Factors against price rising**

With the economic crisis spreading across the world, automobile industry has been heavily effected, which leads to a decline of demand for germanium used in civil infrared optical industry; Some suppliers having panic sentiment may cause the price to keep dropping; The demand from downstream market consumers may keep weak as they have a lack of confidence in the future market, resulting in the price falling further.

# Factors contributing to price rising

China's Ministry of Industry and Information says the total public investment expenditure in 3G will reach to around 1.8-2 trillion Yuan during the following three years, which is very significant to cope with a financial crisis, and stimulate economic growth, and is also positive news for germanium market recovering. The demand for germanium in military infrared realm may continue to be strong. The demand for germanium single crystal used in solar energy may go up with the increasing financial investment in this new energy source. Producers may reduce production when demand is weak, which will back up the price.

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