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2011 Minerals Yearbook

DIAMOND

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Diamond, Industrial

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In 2011, U.S. synthetic diamond production was estimated to be 98.2 million carats (Mct) with an estimated value of $67.1 million. U.S. imports of natural and synthetic industrial diamond bort, dust, grit, powder, and stone totaled about 729 Mct valued at almost $146 million, while exports totaled more than 148 Mct valued at almost $70.4 million. The estimated U.S. apparent consumption of industrial diamond bort, dust, grit, powder, and stone totaled 714 Mct with an estimated value of $161 million. Total industrial diamond output worldwide was estimated by the U.S. Geological Survey (USGS) to be about 4.51 billion carats valued between $1.65 and $2.50 billion. This was the combination of more than 135 Mct natural industrial diamond and about 4.38 billion carats synthetic industrial diamond.

Diamond is best known as a gemstone, but some of its unique properties make it ideal for many industrial and research applications as well. Current information on gem-grade diamond can be found in the USGS Minerals Yearbook, volume I, Metals and Minerals, chapter on gemstones. Diamond that does not meet gem-quality standards for clarity, color, shape, or size is used as industrial-grade diamond. Total production and consumption quantities and values in table 1 are estimated based on past and current reported data. Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data. The USGS does not conduct surveys of either domestic polycrystalline diamond (PCD) producers or domestic chemical vapor deposition (CVD) diamond producers for quantity or value of annual production. Also, trade and consumption quantity or value data are not available for PCD or for CVD diamond.

Production

The USGS conducts an annual survey of domestic industrial diamond producers and U.S. firms that recover diamond wastes. Although most of these companies responded to the 2011 survey, one of the three industrial diamond recycling firms did not report data deemed to be proprietary. To protect the proprietary data of other producers and recyclers, only estimates of U.S. primary and secondary output are provided in this review.

As one of the world's leading producers of synthetic industrial diamond, the United States accounted for an estimated output of 98.2 Mct valued at more than $67.1 million in 2011. Only two U.S. companies produced synthetic industrial diamond during the year—Diamond Innovations, Inc. (Worthington, OH) and Mypodiamond, Inc. (Smithfield, PA).

In 2011, at least eight U.S. companies also manufactured PCD from synthetic diamond grit and powder. These companies were Dennis Tool Co. (Houston, TX), Diamond Innovations, Novatek Inc. (Provo, UT), Precorp Inc. (Provo), Sii MegaDiamond Inc. (Provo), Tempo Technology Corp. (Somerset, NJ), US Synthetic Corp. (Orem, UT), and Western Diamond Products LLC (Salt Lake City, UT).

In 2011, Apollo Diamond, Inc. (Boston, MA) ceased manufacture of single-crystal CVD diamond for gemstone and industrial use. The single-crystal CVD diamond was grown using a method Apollo Diamond developed and patented in the early 2000s in which the CVD technique transforms carbon into plasma, which then is precipitated onto a substrate as diamond. On August 31, 2011, SCIO Diamond Technology, Corp. acquired the diamond growing machines and the related intellectual property rights from Apollo Diamond. On June 5, 2012, SCIO Diamond Technology acquired cultured diamond gemstone-related technology, inventory, and various intellectual property rights from Apollo Diamond Gemstone Corp. SCIO Diamond Technology transferred all diamond growing equipment to their labs in Greenville, SC, and planned to begin manufacturing single-crystal CVD diamonds during 2012 (Yahoo Finance, 2012).

During 2011, an estimated 35 Mct of used industrial diamond worth about $17.7 million was recycled in the United States. Recycling firms recovered most of this material from used diamond drill bits, diamond tools, and other diamond-containing wastes. Additional diamond was recovered during the year from residues generated in the manufacture of PCD.

The recovery and sale of industrial diamond was the principal business of three U.S. companies in 2011—Industrial Diamond Laboratory, Inc. (Bronx, NY), International Diamond Services Inc. (Houston, TX), and National Research Co. (Fraser, MI). In addition to these companies, other domestic firms may have recovered industrial diamond in smaller secondary operations.

No diamond mines commercially operated in the United States during 2011. The last commercially operated diamond mine in the United States closed in 2002 and was fully reclaimed.

Consumption

Diamond is the hardest known material and has the highest thermal conductivity of any material at room temperature. Diamond is more than twice as hard as its nearest competitors, cubic boron nitride and silicon nitride. Because it is the hardest substance known, diamond has been used for centuries as an abrasive in cutting, drilling, grinding, and polishing. Industrial-grade diamond continues to be used as an abrasive for many applications. Even though it has a higher unit cost, diamond has proven to be more cost-effective in many industrial processes because it cuts faster and lasts longer than alternative abrasive materials (Boucher, 1997, p. 26.6). Diamond also has chemical, electrical, optical, and thermal characteristics that make it the best material available to industry for wear- and corrosion-resistant coatings, special lenses, heat sinks in electrical circuits, wire drawing, computing, and other advanced technologies.

Both synthetic and natural diamonds have industrial uses. Synthetic industrial diamond is superior to its natural diamond counterpart because its properties can be tailored to specific applications, and it can be produced in large quantities. For these reasons, synthetic diamond accounted for about 97% by weight of the industrial diamond used in the United States and about 97% by weight of the industrial diamond used in the world during 2011.

The United States remained the world's leading market for industrial diamond in 2011. Based on production estimates and trade data, U.S. apparent consumption of industrial diamond during the year increased 17% to an estimated 714 Mct valued at $161 million compared with 612 Mct valued at $150 million in 2010. This increase was owing to industrial sectors that consume industrial diamond beginning to recover from the negative impacts of the economic recession. The apparent consumption was the combination of 23.4 Mct of natural industrial diamond valued at $58.5 million and 690 Mct of synthetic industrial diamond valued at $102 million. By type, the apparent consumption was the combination of 619 Mct of diamond bort, grit, dust, and powder valued at $41.1 million and 95 Mct of diamond stone valued at $120 million.

The major consuming industries of industrial diamond in the United States during 2011 were construction, machinery manufacturing, mining services (exploration drilling for minerals, natural gas, and oil), stone cutting/polishing, and transportation systems (infrastructure and vehicles). Within these sectors, stone cutting and highway building/repair, combined, made up the largest demand for industrial diamond. Research and high-technology uses included close-tolerance machining of ceramic parts for the aerospace industry, heat sinks in electronic circuits, lenses for laser radiation equipment, polishing of silicon wafers and disk drives, and other applications in the computer industry.

Diamond tools have numerous industrial functions. Diamond drilling bits and reaming shells are used principally for minerals, natural gas, and oil. Other applications of diamond bits and reaming shells include foundation testing, masonry drilling, and inspecting concrete. The primary uses of point diamond tools are for dressing and truing grinding wheels and for boring, cutting, finishing, and machining applications. Beveling glass for automobile windows is another application. Cutting dimension stone and cutting/grooving concrete in highway reconditioning are the main uses of diamond saws; other applications include cutting composites and forming refractory shapes for furnace linings. Very fine diamond saws are used to slice brittle metals and crystals into thin wafers for electronic and electrical devices. Diamond wire dies are essential for high-speed drawing of fine wire, especially from hard, high-strength metals and alloys. The primary uses of diamond grinding wheels include edging plate glass, grinding dies, grinding parts for optical instruments, and sharpening and shaping carbide machine tool tips.

Two types of natural diamond are used by industry—diamond stone (generally larger than 60 mesh/250 micrometers) and diamond bort (smaller, fragmented material). Diamond stone is used mainly in drill bits and reaming shells used by mining companies; it also is incorporated in single- or multiple-point diamond tools, diamond saws, diamond wheels, and diamond wire dies. Diamond bort is used for drill bits and as a loose grain abrasive for polishing. Other tools that incorporate natural diamond include bearings, engraving points, glass cutters, and surgical instruments.

Synthetic diamond grit and powder are used in diamond grinding wheels, saws, impregnated bits and tools, and as a loose abrasive for polishing. Diamond grinding wheels can be as large as 1 meter in diameter.

Loose powders made with synthetic diamond for polishing are used primarily to finish cutting tools, drill bits, gemstones, jewel bearings, optical surfaces, reaming shells, silicon wafers, and wire-drawing dies for computer chips. Hundreds of other products made from ceramics, glass, metals, and plastics also are finished with diamond powders.

Two types of PCDs used by industry are polycrystalline diamond compacts (PDCs) and polycrystalline diamond shapes (PDSs). The use of PDCs and PDSs continues to increase for many of the applications cited above, including some of those that employ natural diamond. PDCs and PDSs are used in the manufacture of single- and multiple-point tools, and PDCs are used in a majority of the diamond wire-drawing dies.

Since its introduction in the mid-1980s, CVD diamond has seen strong growth and is being increasingly accepted by multiple industries as an enhanced material of choice owing to its properties of exceptional strength, durability, stiffness, high thermal conductivity, and electrical isolation. The global market value of industrial diamond and diamond-like films and coatings was estimated to have been more than $905 million in 2010, and was expected to increase to more than $1.7 billion by 2015.

Early applications for CVD diamond focused largely around thin- and thick-film PCD for cutting tools and dressing applications because of the mechanical properties of diamond. Newer applications that take advantage of CVD diamond's mechanical properties include wear parts, such as watch gears and chemical mechanical polishing pad conditioners. Diamond has tremendous potential for electronics applications because it significantly improves upon current strategies for thermal management while remaining highly cost-competitive with other approaches. CVD diamond is used in microelectronic components, such as high-speed processors, medical devices, wide bandgap radio frequency (RF) devices, power conversion devices, and opto-electronic devices (light emitting diodes, laser diodes) that generate exceptionally high heat densities requiring innovative approaches to thermal management. In the manufacture of semiconductors, wafer scale diamond offers enhanced mechanical properties, such as significantly higher stiffness, strength, hardness, thermal conductivity, and chemical inertness than silicon and most other thin-film materials, which are commonly used. Diamond coatings are finding increasing use in electronic applications because of the high thermal conductivity of diamond (10 times that of silicon). Micro-electro-mechanical systems (MEMS), such as RF MEMS resonators, have design needs that offer a compelling case for the use of diamond as a base material because of superior properties (high Young's Modulus and its durability in harsh environments). Researchers are investigating the use of boron-doped diamond (BDD) electrodes for water treatment owing to diamond's potential as an environmentally friendly, high performance electrode material. BDD electrodes have many characteristics that make them ideal for eliminating organic contaminants from water (Zimmer, 2011).

Historically, diamond has been perceived as an expensive material. Advances in CVD diamond manufacturing such as the development of microwave carbon plasma technology and the development of higher-throughput hot filament (HF) CVD diamond reactors have significantly reduced diamond costs. This led many industries to revisit development activities and actively pursue the use of CVD diamond for a growing number of applications (Zimmer, 2011).

In addition to the existing opportunities for their cultured diamond gemstones, SCIO Diamond Technology was developing projects using single-crystal CVD diamond materials in high-voltage power switches, lasers, quantum communications and computing, and water treatment and purification. SCIO Diamond Technology thought that these projects could translate into $1 billion-plus market opportunities and high volume technology applications in the next 2 to 5 years (SCIO Diamond Technology, Corp., 2012).

Prices

Price increases for natural diamond were driven by strong demand at auctions held in all of the global diamond centers. This affected prices of industrial diamond as well as gemstone diamond. These price increases were a reflection of strong demand for the whole range of rough diamonds for industrial markets (Roffman, 2011).

Natural and synthetic industrial diamonds differ significantly in price. Natural industrial diamond normally has a more limited range of values, from about $0.49 per carat for bort-size material to about $2.50 to $10 per carat for most stones, with some larger stones selling for $200 per carat or more. Prices of synthetic diamond vary according to size, shape, crystallinity, and the absence or presence of metal coatings. In general, prices for synthetic diamond for grinding and polishing range from as low as $0.26 per carat to $2.50 per carat. Strong and blocky material for sawing and drilling sells for $2.50 to $4.00 per carat. Large, synthetic crystals with excellent structure for specific applications sell for several hundred dollars per carat. During 2011, U.S. imports of all types of industrial diamond had an average value of $0.20 per carat. These imports were a combination of imports of diamond bort, grit, and dust and powder (natural and synthetic) that had an average value of $0.13 per carat and imports of diamond stone (natural and synthetic) that had an average value of $19.70 per carat.

Foreign Trade

The United States continued to lead the world in industrial diamond trade in 2011; imports were received from 32 countries and exports and reexports were sent to 33 countries (tables 2–5). Although the United States has been a major producer of synthetic diamond for decades, expanding domestic markets have become more reliant on foreign sources of industrial diamond in recent years. U.S. markets for natural industrial diamond have always been dependent on imports and secondary recovery operations because natural diamond has not been produced domestically.

During 2011, U.S. imports of industrial-quality diamond stones (natural and synthetic) increased by 43% from those of 2010 to about 2.46 Mct valued at about $48.4 million (table 2). The average value of these industrial-quality diamond stone imports was $19.70 per carat. Imports of diamond dust, grit, and powder (natural and synthetic) increased from those of 2010 to 726 Mct valued at about $97.7 million (table 3). The average value of these industrial diamond dust, grit, and powder imports was $0.13 per carat.

Reexports account for a significant portion of total exports/reexports; therefore, exports and reexports are listed separately in tables 4 and 5 so that U.S. trade and consumption can be calculated more accurately. During 2011, the United States did not export industrial diamond stones, unchanged from 2010. U.S. reexports of industrial diamond stone increased by 17% from those of 2010 to 1.26 Mct valued at $32.1 million and an average value of $25.50 per carat (table 4). U.S. exports of industrial diamond dust, grit, and powder (natural and synthetic) increased by 32% from those of 2010 to 148 Mct valued at $70.4 million and an average value of $0.47 per carat. Reexports of industrial diamond dust, grit, and powder (natural and synthetic) increased slightly from those of 2010 to 18.5 Mct valued at $11.0 million and an average value of $0.60 per carat (table 5).

World Industry Structure

In 2011, industrial diamond was produced in 27 countries (tables 6, 7). Total industrial diamond output worldwide was estimated by the USGS to be about 4.44 billion carats valued between $1.65 and $2.50 billion. Natural industrial diamond production worldwide was estimated to be more than 60.5 Mct, a slight decrease compared with that of 2010. Congo (Kinshasa) was the leading producing country, followed by Russia, Zimbabwe, and Australia, in descending order of quantity. These four countries produced more than 76% of the world's natural industrial diamond (table 6). Synthetic industrial diamond production worldwide was estimated to be more than 4.38 billion carats, a slight increase compared with that of 2010. China was the leading producing country, followed by the United States, Russia, Ireland, and South Africa, in descending order of quantity. These five countries produced about 98% of the world's synthetic industrial diamond (table 7).

In addition to the countries listed in table 7, Germany and the Republic of Korea produced synthetic diamond, but specific data on their output could not be confirmed. In 2011, 97% of the total global natural and synthetic industrial diamond output was produced in China, Ireland, Russia, South Africa, and the United States. Synthetic diamond accounted for more than 99% of global diamond production and consumption.

World Review

Global natural diamond production decreased slightly during 2011 to 135 Mct. The world's leading rough diamond producers, in decreasing order of quantity produced, were: Russia, producing 33.5 Mct or 25% of total world production; Botswana, with 32.0 Mct (24%); Congo (Kinshasa), with 19.5 Mct (14%); Canada, with 10.8 Mct (8%); Angola and Zimbabwe, with 9.00 Mct (7%) each; Australia, with 7.59 Mct (6%); South Africa, with 7.00 Mct (5%); and other countries, with 6.16 Mct (5%) (table 6).

Worldwide diamond exploration allocations increased in 2011 after 3 years of declines with 70 companies allocating $449 million, compared with 99 companies allocating $357 million during 2010. This made the diamond share of overall worldwide exploration spending 3%. Africa no longer was the most popular diamond exploration location, after 7 years in a row of being the leading exploration spending spot (Metals Economics Group, 2011).

Worldwide in 2011, average diamond values increased 10% to $97.67 per carat from the 2010 average value of $88.79 per carat. This increase was indicated by increases in the U.S. markets, which demonstrated increasing quantity and value of diamond imports in 2011 compared with those of 2010, and improved sales in North America overall (Metals Economics Group, 2012).

Despite higher diamond prices, only two new projects were commissioned in 2011. The Kao Mine in Lesotho began operation, and the expansion of the Williamson Mine in Tanzania was commissioned in December 2011 (Metals Economics Group, 2012).

Canada.—Canadian diamond production was about 10.8 Mct during 2011, a decrease of about 8% compared with that of 2010. Diamond exploration continued in Canada, with several commercial diamond projects and additional discoveries in Alberta, British Columbia, the Northwest Territories, the Nunavut Territory, Ontario, and Quebec. In 2011, Canada produced 8% of the world's combined natural gemstone and industrial diamond output.

The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its 13th full year of production in 2011. Ekati produced 2.07 Mct of diamond from 4.60 million metric tons (Mt) of ore. BHP Billiton Ltd. has an 80% controlling ownership in Ekati, which is in the Northwest Territories. Ekati has estimated remaining reserves of 33.9 Mt of ore in kimberlite pipes that contain 16.2 Mct of diamond. BHP Billiton projected the remaining mine life to be 11 years. Approximately 21% of the Ekati 2011 diamond production is industrial-grade material (Perron, 2011, p. 1; BHP Billiton Ltd., 2012, p. 10).

The Diavik Diamond Mine, Canada's second diamond mine, also located in the Northwest Territories, completed its ninth full year of production. Diavik produces an average of 2 million metric tons per year (Mt/yr), grading an average of 3.1 carats per ton. At yearend 2011, Diavik estimated the mine's remaining proven and probable reserves to be 18.9 Mt of ore in kimberlite pipes containing 58.9 Mct of diamond and projected the total mine life to be 16 to 22 years. Diavik began developing an underground mine and substantially completed construction on the project during 2009. The first ore was produced from the underground mine during the first quarter of 2010, with full production expected in 2013. The mine is an unincorporated joint venture between Diavik Diamond Mine Inc. (60%) and Harry Winston Diamond Mines Ltd. (40%) (Perron, 2011, p. 2; Diavik Diamond Mine Inc., 2012, p. 5).

Canada's third diamond mine, the Jericho Diamond Mine in Nunavut, was originally owned by Tahera Diamond Corp. Tahera estimated the Jericho Diamond Mine's reserves to be about 5.5 Mt of ore grading 0.85 carats per ton. The Jericho Diamond Mine experienced startup problems related to ore mining and processing. The mine also suffered financial problems owing to the cost of transporting supplies to the mine site, high operational costs, high oil prices, and appreciation of the Canadian dollar versus the United States dollar. All of these problems combined to force the company to enter into protection under Canada's "Companies' Creditors Arrangement Act" on January 16, 2008, and the mine suspended production on February 6, 2008. At yearend 2009, Tahera was finalizing arrangements to sell all of its Jericho Diamond Mine assets (Perron, 2011, p. 2). In July 2010, Shear Minerals Ltd. (now known as Shear Diamonds Ltd.) announced that it had entered into a purchase agreement with Tahera and Benachee Resources Inc. to acquire a 100% interest in the Jericho Diamond Mine, the mine's processing facilities, and all supporting exploration assets in the Kitikmeot region of Nunavut (Shear Minerals Ltd., 2010). Shear Minerals completed the acquisition of the Jericho Diamond Mine in August 2010 with the intention of bringing the mine back into production during 2012 (Shear Minerals Ltd., 2011).

The Snap Lake Mine, in the Northwest Territories, is wholly owned by De Beers Canada Inc. The Snap Lake deposit is a tabular-shaped kimberlite dike rather than the typical kimberlite pipe. The dike is 2.5 meters thick and dips at an angle of 12° to 15°. The deposit was mined using a modified room and pillar underground mining method in 2011. The Snap Lake Mine started mining operations in October 2007, reached commercial production levels in the first quarter of 2008, and officially opened June 25, 2008. The mine was expected to produce 1.4 Mct per year of diamond, and the mine life was expected to be about 20 years. The mine's production for 2011 amounted to 881,000 carats for a recovered grade of 1.2 carats per ton (De Beers Canada Inc., 2011; Perron, 2011, p. 2–3; De Beers Group Inc., 2012).

The Victor Mine, in northern Ontario on the James Bay coast, also is wholly owned by De Beers Canada. The Victor kimberlite consists of two pipes with surface area of 15 hectares (37.1 acres). The Victor Mine initiated mining operations at the end of December 2007 and was officially opened on July 26, 2008. The Victor reportedly has 27.4 Mt of ore with average ore grade of 0.23 carats per ton estimated minable reserves. At full capacity, the open pit mine was expected to produce 600,000 carats per year, and the mine life was expected to be about 12 years. In 2011, the mine's production was 779,000 carats recovered from 2.67 Mt of ore (Perron, 2011, p. 3; De Beers Group Inc., 2012; De Beers Canada Inc., undated).

Lesotho.—The Kao Mine, owned by Namakwa Batla Diamonds Co., began processing kimberlite ore in late November 2011 and began commercial production in March 2012. Namakwa expected production of 170,000 carats for 2012 (Metals Economics Group, 2012).

Tanzania.—The refurbishing of the plant at the Williamson Mine began in December 2011. The Williamson Mine is 75% owned by Petra Diamond Ltd. and 25% owned by the Government of Tanzania. Petra began operating the newly rebuilt plant in March 2012, but was waiting for a secure electrical supply before committing to the full expansion to mining 10 Mt/yr of ore (Metals Economics Group, 2012, p. 24).

Outlook

China is expected to remain the world's leading producer of synthetic industrial diamond, with annual production exceeding 4 billion carats. The United States is likely to continue to be one of the world's leading markets for industrial diamond into the next decade and likely will remain a significant producer and exporter of synthetic industrial diamond as well. U.S. industrial diamond production, imports, and apparent consumption is expected to continue to increase as manufacturing sectors that use industrial diamond recover from the negative impact of the economic recession that started in mid-2008. U.S. demand for industrial diamond is likely to continue in the construction sector as the United States continues building and repairing the Nation's highway system.

Diamond offers many advantages for precision machining and longer tool life. In fact, even the use of wear-resistant diamond coatings to increase the life of materials that compete with diamond is a rapidly growing application. Increased tool life not only leads to lower costs per unit of output but also means fewer tool changes and longer production runs (Advanced Materials & Processes, 1998). In view of the many advantages that come from increased tool life and reports that diamond film surfaces can increase durability by a factor of 50, much wider use of diamond as an engineering material is expected.

PCD for abrasive tools and wear parts are likely to continue to replace competing materials in many industrial applications by providing closer tolerances as well as extending tool life. For example, PDCs and PDSs will continue to displace natural diamond stone and tungsten carbide products used in the drilling and tooling industries.

CVD technology can produce extremely pure diamond crystals that have great potential in computer technology in the production of diamond computer chips when their cost becomes competitive. These diamond computer chips will work at a much higher frequency or faster speed and can be placed in a higher-temperature environment than the silicon chips currently used in computers. Eventually, they may replace silicon chips in computers. CVD diamonds annealed using the low-pressure/high-temperature microwave plasma process may have applications such as using the diamond crystals in high-pressure research, optical applications that take advantage of the outstanding transparency of diamond, or using them in quantum computing to store quantum information in vacancy centers in the diamond's crystal lattice.

CVD diamonds will be used to provide a better and more efficient alternative process to existing water purification processes. This technology will use single-crystal diamond electrodes for electrochemical water purification.

Truing and dressing applications will remain a major domestic end use for natural industrial diamond stone. Stones for these applications have not yet been manufactured economically. No shortage of the stone is anticipated, however, because new mines and more producers selling in the rough diamond market will maintain ample supplies. More competition introduced by the additional sources also may temper price increases.

Demand for synthetic diamond bort, grit, and dust and powder is expected to remain greater than for natural diamond material. Constant-dollar prices of synthetic diamond products probably will continue to decline as production technology becomes more cost effective. The decline is even more likely if competition from low-cost producers in China and Russia continues to increase.

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TABLE 1
SALIENT NATURAL AND SYNTHETIC INDUSTRIAL DIAMOND STATISTICS[1]

(Thousand carats and thousand dollars)

	2007	2008	2009	2010	2011
United States:					
Natural:					
Secondary production:					
Quantity[e]	17,200	17,000 [2]	16,700 [2]	16,700	17,300
Value[e]	8,660	8,320	8,150	8,190	8,470
Exports:					
Quantity	4,560	5,580	1,510	2,330	3,710
Value	4,030	4,250	2,280	1,780	1,790
Imports for consumption:					
Quantity	11,300	9,130	4,230	6,440	9,750
Value	39,100	42,600	20,400	34,600	51,900
Synthetic:					
Primary production:					
Quantity[e]	130,000	131,000 [2]	91,000 [2]	93,000	98,200
Value[e]	131,000	132,000	65,100	66,400	67,100
Secondary production:					
Quantity[e]	17,600	17,300 [2]	17,200 [2]	17,100	17,700
Value[e]	9,500	9,360	9,080	9,120	9,260
Exports:					
Quantity	102,000	112,000	65,500	110,000	145,000
Value	52,400	52,400	31,100	51,000	68,600
Imports for consumption:					
Quantity	403,000	486,000	243,000	591,000	719,000
Value	72,700	74,300	39,300	84,200	94,200
Apparent Consumption, natural and synthetic:[3]					
Quantity	472,000	542,000	305,000	612,000	714,000
Value	204,000	210,000	109,000	150,000	161,000
World:					
Production, natural[e]	170,000	154,000	131,000	135,000	135,000
Production, synthetic[e]	4,420,000	4,420,000	4,370,000	4,380,000	4,380,000
Production, natural and synthetic[e]	4,590,000	4,570,000	4,500,000	4,510,000	4,510,000

[e]Estimated.
[1]Data are rounded to no more than three significant digits.
[2]Reported figure.
[3]Domestic primary and secondary production plus imports minus exports.

TABLE 2

U.S. IMPORTS FOR CONSUMPTION OF INDUSTRIAL DIAMOND STONES, BY COUNTRY[1]

(Thousand carats and thousand dollars)

	Natural industrial diamond stones[2]				Miners' diamond, natural and synthetic[3]			
	2010		2011		2010		2011	
Country	Quantity	Value[4]	Quantity	Value[4]	Quantity	Value[4]	Quantity	Value[4]
Australia	42	288	45	845	9	74	3	190
Belgium	23	321	127	749	(5)	21	--	--
Botswana	835	19,800	842	32,600	11	47	15	20
Congo (Kinshasa)	7	111	6	156	2	7	2	17
Ghana	(5)	11	(5)	3	(5)	3	--	--
India	77	218	540	617	3	350	15	681
Namibia	219	1,340	218	1,230	--	--	--	--
Russia	210	4,540	29	190	(5)	5	--	--
South Africa	234	4,140	580	10,200	26	266	15	243
Other	13	663	22	601	10	133	(5)	11
Total	1,660	31,400	2,410	47,200	61	906	50	1,160

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes glazers' and engravers' diamond unset, Harmonized Tariff Schedule of the United States (HTS) codes 7102.21.3000 and 7102.21.4000.

[3]HTS codes 7102.21.1010 and 7102.21.1020.

[4]Customs value.

[5]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 3

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND DUST, GRIT, AND POWDER, BY COUNTRY[1]

(Thousand carats and thousand dollars)

	Synthetic[2]				Natural[2]			
	2010		2011		2010		2011	
Country	Quantity	Value[3]	Quantity	Value[3]	Quantity	Value[3]	Quantity	Value[3]
Belgium	1,540	353	1,720	483	121	79	273	210
China	461,000	35,800	575,000	44,600	1,050	430	1,940	1,170
Germany	53	39	20	21	24	22	40	42
Hong Kong	638	218	28	18	10	5	--	--
India	854	439	1,420	939	1,470	818	1,880	1,210
Ireland	66,200	28,800	62,700	26,800	688	399	490	353
Israel	445	423	--	--	--	--	--	--
Italy	14	14	6	4	--	--	--	--
Japan	2,540	1,970	1,380	1,850	--	--	--	--
Korea, Republic of	22,700	7,600	33,300	11,400	25	6	1	3
Mexico	--	--	65	42	89	59	10	8
Romania	13,200	1,540	16,600	1,590	--	--	--	--
Russia	15,500	2,700	13,700	2,410	--	--	1,930	467
Switzerland	3,130	2,770	7,550	2,320	548	180	314	183
Taiwan	55	15	276	28	--	--	--	--
Ukraine	176	29	20	14	--	--	--	--
United Arab Emirates	243	170	--	--	--	--	84	122
United Kingdom	1,710	636	3,210	780	559	384	234	175
Other	451	169	1,970	341	163	384	134	129
Total	591,000	83,700	719,000	93,600	4,750	2,770	7,320	4,070

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States codes 7105.10.0020, 7105.10.0030, and 7105.10.0050 for synthetic and 7105.10.0011 and 7105.10.0015 for natural.

[3]Customs value.

Source: U.S. Census Bureau.

TABLE 4
U.S.REEXPORTS OF INDUSTRIAL DIAMOND STONES, BY COUNTRY[1]

(Thousand carats and thousand dollars)

	Industrial unworked diamonds[2]			
	2010		2011	
Country	Quantity	Value[3]	Quantity	Value[3]
Reexports:				
Belgium	417	6,680	492	10,500
Brazil	39	195	31	187
Canada	152	993	183	1,070
Germany	11	359	11	539
Hong Kong	49	695	45	810
Israel	26	131	32	77
Japan	145	8,230	136	10,700
Korea, Republic of	25	1,430	28	1,860
South Africa	--	--	30	79
United Arab Emirates	(4)	10	--	--
United Kingdom	72	2,410	178	3,740
Other	147	2,270	96	2,530
Total	1,080	23,400	1,260	32,100

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States code 7102.21.0000.

[3]Customs value.

[4]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 5
U.S. EXPORTS AND REEXPORTS OF INDUSTRIAL DIAMOND DUST, GRIT, AND POWDER, BY COUNTRY[1]

(Thousand carats and thousand dollars)

	Synthetic[2]				Natural[2]			
	2010		2011		2010		2011	
Country	Quantity	Value[3]	Quantity	Value[3]	Quantity	Value[3]	Quantity	Value[3]
Exports:								
Austria	1,790	622	2,960	1,010	--	--	13	4
Belgium	368	90	448	106	--	--	--	--
Brazil	5,530	1,660	4,170	1,140	2	5	--	--
Canada	4,010	3,190	5,930	4,120	216	681	195	534
Germany	3,490	1,200	3,660	1,340	9	7	86	38
Hong Kong	40	35	166	92	4	10	72	37
India	2,790	1,050	3,200	1,060	2	7	31	6
Ireland	25,300	8,780	39,900	14,700	25	74	42	53
Israel	50	33	56	36	516	165	--	--
Italy	3,910	1,290	3,530	835	--	--	7	4
Japan	29,000	13,800	35,100	17,400	7	9	7	6
Korea, Republic of	7,240	3,770	12,700	8,960	71	13	1,800	348
Mexico	366	164	891	231	443	208	427	217
Singapore	846	2,480	640	1,250	--	--	--	--
Spain	68	14	77	28	--	--	--	--
Switzerland	7,460	5,630	8,550	7,410	554	290	393	212
Taiwan	4,340	1,710	5,820	2,360	26	8	5	12
Thailand	5,100	1,540	5,140	1,430	--	--	--	--
United Kingdom	3,630	1,250	3,050	825	401	224	521	196
Other	4,850	2,720	8,740	4,240	58	80	113	119
Total	110,000	51,000	145,000	68,600	2,330	1,780	3,710	1,790
Reexports:								
Belgium	35	39	158	80	119	228	51	150
Brazil	792	229	733	285	--	--	--	--
Canada	7,150	4,120	9,240	6,500	118	433	128	528
Germany	11	8	31	8	7	24	5	15
India	66	30	--	--	--	--	--	--
Ireland	1,070	421	258	102	5	5	18	16
Italy	250	73	--	--	--	--	--	--
Japan	5,830	1,330	5,360	1,220	87	77	126	223
Korea, Republic of	1,220	530	891	351	7	9	53	75
Mexico	72	31	59	33	38	90	50	86
United Kingdom	323	192	55	59	7	3	33	46
Other	1,020	803	1,090	767	29	53	132	499
Total	17,800	7,810	17,900	9,400	417	922	596	1,640
Grand total	128,000	58,800	163,000	78,000	2,750	2,700	4,310	3,420

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States codes 7105.10.0025 for synthetic and 7105.10.0010 for natural.

[3]Customs value.

Source: U.S. Census Bureau.

TABLE 6

NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE[1, 2, 3]

(Thousand carats)

Country and type[4]	2007	2008	2009	2010	2011
Gemstones:					
Angola	8,732	8,016	12,445	7,600 r	8,100
Armenia	123	101	50	50 e	80
Australia	231	273	220 e	100 e	86
Botswana[e]	25,000	25,000	24,000	25,000	25,000
Brazil	182 e	71 r	21 r	25 r	25 p
Canada	17,144	14,803	10,946	11,773	10,795
Central African Republic[e]	370	302 5	249 5	240 r	250
China[e]	100	100	100	100	100
Congo (Kinshasa)	5,700	4,200	3,700	3,400 r	3,900
Ghana	671	478	301	267 r	300 e
Guinea	815	2,500	557	280 r	300 e
Guyana	269	169 r	144	50 e	50
Lesotho[e]	454 5	450	450	460	450
Namibia	2,266	2,435	1,192	1,693 r	1,700 e
Russia[e]	23,300	21,925 5	17,791 5	17,800	18,500
Sierra Leone	362	223	241	306 r	280 e
South Africa[e]	6,100	5,200	2,500	3,500	2,800
Tanzania[e]	239	202	155	77	51
Venezuela[e]	45	45	45	45	45
Zimbabwe[e]	100	100	100	900 r	1,000
Other[6]	75	121	79	221 r	221
Total	92,300	86,700 r	75,300 r	73,900 r	74,000
Industrial:					
Angola[e]	970	900	1,383 5	900 r	900
Australia	18,960	15,397	10,700	9,900 e	7,500 e
Botswana[e]	8,000	8,000	7,000	7,000	7,000
Brazil[e]	600	600	600	600	600
Central African Republic[e]	93	74 5	62 5	62 r	62
China[e]	970	1,000	1,000	1,000	1,000
Congo (Kinshasa)	22,600	16,700	14,600	13,400 r	15,600
Ghana	168	120	75	67 r	67 e
Guinea	200	600	139	94 r	95 e
Russia[e]	15,000	15,000	15,000	15,000	15,000
Sierra Leone	241	149	160	131 r	120 e
South Africa[e]	9,100	7,700	3,600	5,400	4,200
Tanzania[e]	44	36	27	14	9
Venezuela[e]	70	70	70	70	70
Zimbabwe[e]	600	700	850	7,500	8,000
Other[7]	84	145	115	285 r	285
Total	77,700	67,200	55,400	61,400 r	60,500
Grand total	170,000	154,000	131,000	135,000 r	135,000

[e]Estimated. [p]Preliminary. [r]Revised.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through June 2, 2012.

[3]In addition to the countries listed, Nigeria and the Republic of Korea produce natural diamond, but information is inadequate to formulate reliable estimates of output levels.

[4]Includes near-gem and cheap-gem qualities.

[5]Reported figure.

[6]Includes Cameroon, Congo (Brazzaville), Gabon (unspecified), India, Indonesia, Liberia, and Togo (unspecified).

[7]Includes Congo (Brazzaville), India, Indonesia, and Liberia.

TABLE 7

SYNTHETIC DIAMOND: ESTIMATED WORLD PRODUCTION, BY COUNTRY[1, 2, 3]

(Thousand carats)

Country	2007	2008	2009	2010	2011
Belarus	25,000	25,000	25,000	25,000	25,000
China	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000
Czech Republic	5	5	-- r	-- r	--
France	3,000	3,000	3,000	3,000	3,000
Ireland	60,000	60,000	60,000	60,000	60,000
Japan	34,000	34,000	34,000	34,000	34,000
Russia	80,000	80,000	80,000	80,000	80,000
South Africa	60,000	60,000	60,000	60,000	60,000
Sweden	20,000	20,000	20,000	20,000	20,000
Ukraine	8,000	4,000 r	NA r	NA r	NA
United States	130,000	131,000 [4]	91,000 [4]	93,000	98,200 [4]
Total	4,420,000	4,420,000	4,370,000 r	4,380,000	4,380,000

[r]Revised. NA Not available. -- Zero.

[1]World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through June 2, 2012.

[3]In addition to the countries listed, Germany and the Republic of Korea also produce significant quantities of synthetic diamond, output is not officially reported, and available information is inadequate to formulate reliable estimates of output levels.

[4]Reported figure.