NDT breaking the 10-carat barrier

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The first small manufactured industrial diamonds were produced in 1953 by the Swedish company ASEA but their accomplishment went unannounced so in 1954, General Electric (GE) produced synthetic diamond crystals using the HPHT method with a belt press. In 1970, using the same type of press, GE created a 0.78-carat polished RBC colourless diamond. In the 1980s and 1990s, Russians used their own technology (“BARS” and “TOROID” high pressure apparatus or HPA with high-pressure presses of up to 25 MN load) to grow industrial and good-quality crystals up to 2 carats in polished size, mostly orange to yellow in colour. In the last 15 years, companies including Lucent, Chatham, AOTC, Genesis (now IIa Technologies) and many other producers in China, Germany, India, Russia, Ukraine, the US and Taiwan have improved the technology yet again and used their expertise to successfully grow diamond crystals that cut to 1 carat up to 2 carats in size. This “next generation” of diamonds exhibited high clarities (VS and VVS) and colours (D-H), as well as new blue and pink colours (after irradiation). Other companies including Scio Diamonds, Washington Diamonds, Taidiam, PDC Diamonds and Pure Grown Diamonds (selling arm of IIa technologies) are also using a very different technology/process of Chemical Vapour Deposition (CVD) to produce laboratory-grown diamonds up to 3 carats in size.

The faceted 10.02-carat E colour and VS1 synthetic diamond is featured here with CGL-GRS’ Branko Deljanin. The clarity of VS1 and the colour of E are combined with a very good polish and symmetry and an excellent cut. The NDT’s ‘landmark’ synthetic diamond is believed to be one of the largest of its kind in the world, and according to our best knowledge, sets the new world record for a faceted synthetic diamond of this quality. The stone was available at the MGJ Conference 2015 in Athens (Greece). Photo by John Chapman.
Production facility and technology

The new world record for the largest laboratory-grown diamond crystal is 60 carats and this gem was produced during the first week of July 2015 at the New Diamond Technology (NDT) facility in St. Petersburg (Russia) during an inspection by Branko Deljanin (CGL-GRS). In April 2015, NDT experimentally produced a 32.26-carat colourless gem-quality diamond crystal. From this stone, the largest lab-grown faceted diamond in the world has been cut. It is a 10.02-carat faceted square emerald-cut synthetic diamond. The NDT facility in St. Petersburg has over 50 HPHT presses (including 25MN load presses equipped with a high-pressure apparatus or HPA type “TOROID” and 50MN load presses type Sk850 equipped with HPA type “Cubic”), producing 5,000 carats of diamonds per month in collaboration with a modern cutting facility where they process and polish the laboratory-grown diamonds. New Diamond Technology Ltd recently entered the synthetic diamond jewellery market after completing eight years of research and successful production of type IIa and IIb crystal plates for specific industrial applications (medical, synchrotron radiation and anvil design). NDT now uses much larger cubic type presses (the latest 850 series, Chinese made), and as a result many large stones can be produced in one run (16 colourless stones, 6-10 carats rough) in a cycle that takes 10 to 12 days on average.

The production of synthetic diamonds for jewellery use is currently only a few percentages of the natural diamond supply. This could change dramatically (double or triple) in the next one or two years if the Chinese manufacturers move their focus from the production of industrial diamond powder to growing single-crystal diamonds and adapt their technologies to produce large crystals using cubic HPHT presses.

Examination and identification

Six of the crystals and polished colourless diamonds, including the record-breaking 10.02-carat E VS1; 5.11-carat I, SI1 and 4.30-carat D, VS2 were tested at the M&A Gemological Instrument facility in Finland by M. Åström and B. Deljanin, and six other samples (including two blue) were tested at the GRS laboratory in Hong Kong by M. Alessandri and Dr. A. Peretti. Both examinations used standard instruments and advanced spectrometers.

Most NDT-grown diamonds studied exhibit high to medium clarity (VVS1-SI1). Based on this clarity, for the majority of stones, it is not possible to distinguish them from similarly coloured natural diamonds by using just a loupe or microscope. Only a few lower-clarity stones (especially crystals) had metallic inclusions that are typical for HPHT-grown diamonds. As expected, none of the samples exhibited any strain pattern when examined under cross polarized filters. This is likely due to a relatively short growth period compared to natural diamonds.

As found with other HPHT-grown diamonds on the market, the short-wave UV (254nm) fluorescence of NDT-grown diamonds were greenish-blue and stronger than long-wave UV (365nm) in half of the samples. An interesting new feature discovered in approximately half of the samples is a weak-medium bluish-orange fluorescence and phosphorescence. These phenomena were not only present when excited by UV lamp but also when exposed to a strong pinpoint light (eg. LED light). These samples were part of NDT’s latest production.
Summary

Diamonds grown by NDT are the largest colourless synthetic diamonds reported to date, with weights up to 60-carat crystals and 10.02-carat faceted. Most samples are of high colour grades (colourless and near-colourless, D-J) and high to medium clarity, but may contain metallic inclusions formed from metal/catalyst. Natural and CVD synthetic diamonds show strong Ia or weak IIa strain patterns as they are more heavily strained than HPHT synthetic diamonds. HPHT synthetic diamonds do not show birefringence under cross polarized filters. Our colourless samples were type Ila with some boron (weak type IIb) or blue samples (type IIb) with high B content. Their natural counterparts, colourless type Ila diamonds are highly transparent and considered the world's most valuable diamonds, usually appearing in large sizes (5 carats – 100 carats-plus) and in high colours (D-E) and clarities (IF-VVS). They are also known as type “Golconda” diamonds because the “best” stones are historically believed to originate from the Golconda province in India. All synthetic diamonds fluoresced and phosphoresced blue under short-wave UV light. In addition, half of them showed orange colour when exposed to a UV lamp, with stronger responses to short-wave than long-wave excitation and lasting phosphorescence. Natural diamonds show a stronger reaction (usually blue) under long-wave UV than short-wave UV light. Phosphorescence in natural diamonds is very rare and almost exclusively found in type IIb and chameleon diamonds, but with red and yellow phosphorescence colours. Therefore, the synthetic diamonds can be distinguished based on their phosphorescence, particularly from their natural type Ila counterparts.

Using a combination of standard gemmological and spectroscopic tests, it is possible to identify all colourless and blue HPHT-grown diamonds. Synthetic diamonds from NDT can therefore be distinguished from natural diamonds of similar quality.

We predict that in the future, large-sized HPHT-grown pink diamonds will be produced using Beta irradiation in combination with HT treatments of type IIb yellow base material, similar to the processes reported to obtain pink colour in CVD diamonds.

One of the authors (BD) has had the opportunity to study HPHT-grown and CVD-grown samples from all producers of synthetic diamonds in the last 15 years and this is first time that HPHT-grown diamonds are exhibiting an orange luminescence (usually a characteristic of CVD-grown colourless diamonds) under short-wave UV-light. The most surprising phenomenon is that even visible pinpoint light triggers this orange reaction. This specific type of fluorescence/phosphorescence offers the possibility for a straightforward and simple “screening test” for larger synthetic diamonds created by NDT (Russia).

For more information and references go to www.gemresearch.ch/news

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