The world's largest size single-crystal substrates

－Succeeded in increasing the size of diamond toward device application－

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EDP Corporation

1. Introduction

EDP has large advantage on the size of single-crystal diamond, which may be applied in semiconducting devices, heat spreader, optical window etc. EDP has realized large seeds for fabricating LGD, Laboratory Grown Diamond, which became popular gem stone.

Until now, the largest single crystal we have sold has been 15x15 mm, and larger sizes have been supplied as mosaic crystals made by jointing two or more single crystals together.

Mass production of the devices requires wafers of 2 inches (50 mm) or larger, and many of our customers have been asking for commercialize such wafers.

As we disclosed the road map of large diamond wafer on November 28, 2024, we have been concentrated to develop 2-inch wafers, and for this purpose, we showed that the first step would be developing single crystals of 25x25 mm or larger. We have made progress in accordance with this roadmap and succeeded in developing one of the world's largest diamonds single crystals measuring 30 x 30 mm or larger, and have released single-crystal substrates measuring 30 x 30 mm or smaller using this diamond single crystal.

2. New Line Up

The large single crystal we have developed is shown in the attached photo. The actual dimensions are 32x31.5 mm. Using this as the parent crystal, we will mass produce single crystals of the same size using our proprietary method using ion implantation. The single-crystal substrates we have released for diamond device development are as shown below.

Size : 15x15 to 30x30 mm (single-crystal substrates of 15x15 mm or smaller are already on the market)

Thickness : 0.05 to 2mm

Surface orientation : (100) plane with an off angle of about 3° .

Nitrogen content : 8ppm or less

X-ray rocking curve FWHM : From 20 to 80arcsec (same as conventional products)

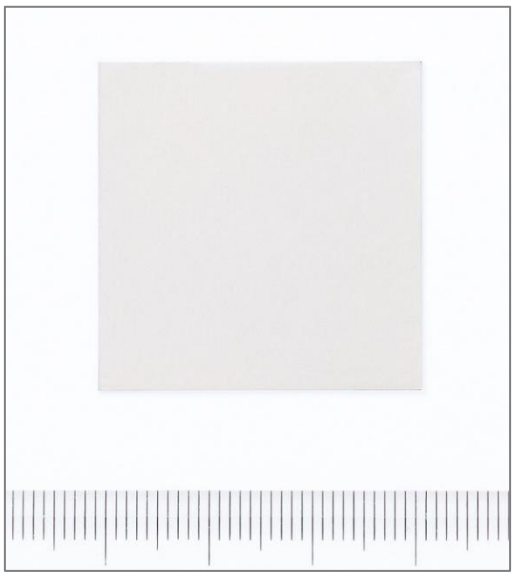

Photo: Large diamond single crystal (32x31.5mm)

3. Applications and commercialization

We have already released substrates up to 15x15 mm in size, and for larger substrates, mosaic crystals consisting of multiple single crystals connected together have been used, but now single crystals can be used up to 30x30 mm. This allows stable device fabrication processes such as microfabrication processes.

In addition, single-crystal diamond has the highest thermal conductivity of all materials and is expected to be used as a heat sink to remove heat generated by devices. The ability to fabricate large wafers is expected to enable diamond heat sinks to be made at a lower cost, thereby expanding the range of applications.

4. Future plan

We plan to launch 1-inch wafers (25 mm in diameter) using this large single crystal, the target commercialization on the end of next April. Before commercialization, we will determine various wafer specifications, including surface roughness and waviness, as well as edge geometry.

Furthermore, as shown in the disclosure on November 28, 2024, we plan to commercialize 2-inch wafers (50 mm in diameter) in year of 2025 by promoting the development of mosaic crystals with an area of 50x50 mm or larger by jointing four of single crystals we have developed, with the aim of developing 2-inch wafers (50 mm in diameter). Semiconductor device manufacturing equipment compatible with 2-inch wafers is currently available and will facilitate the use of manufacturing processes required for semiconductor devices, such as microfabrication.

As described in the roadmap above, we intend to increase the single crystal size to 50x50mm and realize 2-inch single-crystal wafers, which is expected to take 2-3 years to develop.

If we can develop single crystals larger than 50x50mm, we can connect four of them to realize a 4-inch mosaic wafer (100mm in diameter). Considering the current state of the semiconductor process, this 4-inch mosaic wafer is considered an essential material for the full-scale mass production of diamond devices, and we will accelerate the development of this wafer even faster than before, aiming for its early commercialization.