GDCS

A STANDARD OF THE ASSOCIATION FOR INTELLIGENT DIAMOND INTERNATIONAL

GDCS TESTING STANDARD

Laboratory-Grown Diamond (Synthetic Diamond) Testing and Grading Standard

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CONTENTS

Foreword

1 Scope

2 Normative References

3 Terms, Definitions, and Abbreviations

4 Basic Principles

5 General Testing Conditions (Uniformly Enforced)

6 Product Classification

7 Testing Methods and Testing Characteristics

8 Quality Grading Rules

9 Inspection Rules

10 Marking Specifications

11 Laboratory-Grown Diamond Certificate

12 Packaging, Transportation, and Storage

13 Supplementary Provisions

Appendix A (Informative) Internal and External Characteristic Types of Laboratory-Grown Diamonds

Appendix B (Informative) Colored Laboratory-Grown Diamond Color Observation Diagram

Appendix C (Informative) Common Cut Types and Cut Proportions of Laboratory-Grown Diamonds

Foreword

This document is drafted in accordance with the provisions of GB/T 1.1—2020 *Directives for Standardization Work — Part 1: Structure and Drafting Rules of Standardization Documents*.

This document integrates the core content of the T/GAC 18—2024 group standard *Synthetic Diamond (Laboratory-Grown Diamond)* and the GDCS Synthetic Diamond Grading Standard. While retaining the testing methods and identification characteristic system of T/GAC 18—2024, it introduces the GDCS four-dimensional determination system (instrumental physical parameter quantification + Pantone FHI TPG candidate color number color mapping + inclusion/structure quantification + process characteristic quantification), forming a complete testing standard covering the entire chain of identification, grading, marking, and certification.

This document uniformly adopts the four-dimensional determination system of "instrumental physical parameter quantification + Pantone FHI TPG candidate color number color mapping + inclusion/structure quantification + process characteristic quantification" throughout, adapted to mainstream HPHT and CVD synthesis processes.

Note: This standard uses the current Pantone FHI TPG physical color card (2,801 colors) as the color communication and candidate mapping reference, to adapt to the color comparison needs of jewelry props, packaging, and diamond bodies on paper/hard carriers. TPG color numbers are candidate mapping values and must be approved through the current physical color card, controlled D65 lighting, specified observation geometry, and multi-person independent judgment before they can be used as grading references.

Please note that certain contents of this document may involve patents. The issuing body of this document does not assume responsibility for patent identification.

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1 Scope

1.1 This document specifies the terms and definitions, product classification, technical requirements, testing methods, quality grading, inspection rules, marking, packaging, transportation, and storage of synthetic (laboratory-grown) diamonds.

1.2 This document applies to the testing and quality grading of synthetic diamonds (laboratory-grown diamonds) in loose stone and mounted finished product forms produced by High Pressure High Temperature (HPHT) and Chemical Vapor Deposition (CVD) methods. Unmounted polished laboratory-grown diamonds shall be implemented in accordance with this document; mounted polished laboratory-grown diamonds shall refer to this document for implementation.

1.3 This document does not apply to diamonds subjected to artificial post-treatment such as dyeing, coating, film coating, irradiation color modification, or filling. It only applies to synthetic (laboratory-grown) diamonds with stable primary body color and no post-treatment. All optimized treatment samples are outside the scope of this standard's grading.

2 Normative References

The following documents are indispensable for the application of this document. For dated references, only the dated version applies to this document; for undated references, the latest version (including all amendments) applies to this document.

- GB/T 16552—2017 Jewelry and Jade — Names
- GB/T 16553—2017 Jewelry and Jade — Identification
- GB/T 16554—2017 Jewelry and Jade — Grading Lighting and Observation Conditions
- GB/T 23885—2017 Diamond Grading
- Pantone FHI TPG Physical Standard Color Card (current version, dedicated for color comparison of jewelry and derivative products)
- T/GAC 18—2024 Synthetic Diamond (Laboratory-Grown Diamond)

3 Terms, Definitions, and Abbreviations

3.1 Terms and Definitions

The terms and definitions defined in GB/T 16552—2017, GB/T 16553—2017, GB/T 16554—2017, and the following apply to this document.

3.1.1 Laboratory-grown diamond (Synthetic diamond)

An isometric crystalline substance composed of carbon atoms formed completely or partially through an artificial crystal growth process, with physical properties, chemical composition, and crystal structure basically identical to natural diamond. Also known as synthetic diamond. The crystal structure and physical-chemical properties are basically consistent with natural diamond, divided into HPHT synthetic diamond and CVD synthetic diamond.

3.1.2 HPHT synthetic diamond (High Pressure High Temperature laboratory-grown diamond)

A laboratory-grown diamond formed by epitaxial crystal growth on a diamond seed crystal under high temperature and high pressure and the action of a molten metal catalyst, using graphite-small particle diamond as the carbon source. Abbreviated as HPHT laboratory-grown diamond.

3.1.3 CVD synthetic diamond (Chemical Vapor Deposition laboratory-grown diamond)

A laboratory-grown diamond formed by using carbon-containing gas as the carbon source, and under certain conditions promoting carbon atoms to precipitate on a seed crystal pre-placed in a growth chamber according to the diamond structure, continuously growing. Abbreviated as CVD laboratory-grown diamond.

3.1.4 Colorless synthetic diamond

A synthetic diamond with no obvious colored hue in the crystal, with the body color appearing colorless or near-colorless.

3.1.5 Colored synthetic diamond

A synthetic diamond that produces a stable primary colored body color during growth due to the incorporation of impurity elements (such as N, B) or lattice defects, covering color series such as yellow, pink, blue, red, green, and brown, without any post-artificial color modification or optimization treatment traces.

3.1.6 Clarity characteristics

The collective term for inclusions and appearance defects such as inclusions, growth lines, pinpoints, fractures, cavities, and impurity spots present inside and on the surface of synthetic diamonds.

3.1.7 Cut

The faceted shape formed by cutting, grinding, and polishing a synthetic diamond rough stone. The core evaluation indicators include proportions, symmetry, and polish quality.

3.1.8 Pantone FHI TPG color card

Pantone Fashion, Home + Interiors series paper-coated standard color card (Textile Paper - Green Label), containing the current 2,801 colors. This standard uses it as a candidate mapping and communication tool for colored laboratory-grown diamond color grading. It is not equivalent to diamond optical color and does not automatically determine grade.

3.1.9 Main hue

The core hue stably presented by the overall colored laboratory-grown diamond under specified table-up orientation, controlled lighting, and specified observation direction. The main hue is used for color grade description and does not require the exclusion of all local secondary colors.

3.1.10 Candidate color number

A color number selected from the current FHI TPG color card or official controlled digital resources but not yet physically approved. Candidate color numbers are only used for retrieval, communication, and establishing internal worksheets, and shall not be directly used as grading conclusions.

3.1.11 Transitional grade

When a sample cannot be clearly distinguished between two adjacent grades or adjacent color number ranges, boundary recording is adopted. Transitional grades shall not be rounded up to improve marketing grades.

3.1.12 Determination priority

The pre-specified evidence order and handling rules for obtaining reproducible conclusions when different evidence conflicts. Priority does not equal the natural ranking of scientific reliability of evidence, but is a procedural rule specified in this document.

3.1.13 Measurement uncertainty

A parameter characterizing the dispersion of reasonably assigned measured values. For instrumental values, components such as repeatability, calibration, instrument resolution, and sample variation should be identified; for visual results, differences such as observers, lighting, background, sample orientation, and method interpretation should be identified.

3.1.14 Growth sector

The characteristic structural pattern exhibited by different mass point arrangement sectors inside a laboratory-grown diamond crystal under cathode ray or ultra-short wave ultraviolet irradiation.

3.1.15 Layer growth striation

The characteristic structural pattern exhibited by different mass points inside a laboratory-grown diamond crystal distributed in regular layers under cathode ray or ultra-short wave ultraviolet irradiation.

3.1.16 Metallic solvent

A metal flux that promotes the conversion of graphite to laboratory-grown diamond during the HPHT laboratory-grown diamond growth process. Common metal catalysts are alloys composed of metals such as iron, nickel, and cobalt.

3.1.17 Laboratory-grown diamond grading

The classification of laboratory-grown diamonds from aspects such as color, clarity, and cut. Also known as laboratory-grown diamond quality evaluation.

3.1.18 Fancy shape cut grading

The classification of the fancy processing craftsmanship of laboratory-grown diamonds from symmetry and polish through observation and measurement.

3.1.19 Symmetry

The evaluation of the precision of the cutting shape of laboratory-grown diamonds, including symmetrical arrangement and facet positions.

3.1.20 Polish

The evaluation of the impact of external characteristics generated during the cutting and polishing process of laboratory-grown diamonds on the perfection of the polished surface.

3.2 Abbreviations

Abbreviation	Full Name	Description
GDCS	Gem & Diamond Certificate Standard	The standard under which this document is issued
AIDI	Association for Intelligent Diamond International	Association for Intelligent Diamond International
HPHT	High Pressure High Temperature	High pressure high temperature method
CVD	Chemical Vapor Deposition	Chemical vapor deposition method
FHI	Fashion, Home + Interiors	Pantone Fashion, Home + Interiors color system
TPG	Textile Paper - Green Label	Paper-coated color card format
D65	Standard Illuminant D65	Standard illuminant D65 (simulating average northern sky daylight, color temperature approximately 6500K)
CIE	International Commission on Illumination	International Commission on Illumination
LAB	CIE 1976 Lab* Color Space	CIE 1976 Lab* color space
UV	Ultraviolet	Ultraviolet light
N/B/H	Nitrogen / Boron / Hydrogen	Nitrogen/Boron/Hydrogen (diamond characteristic doping elements)
LGD	Laboratory-Grown Diamond	Laboratory-grown diamond
SD	Synthetic Diamond	Synthetic diamond

4 Basic Principles

4.1 Separation of Identification and Grading

Sample name, synthesis attributes, synthesis process tendency, treatment status, and identification conclusions shall be independently evaluated in accordance with GB/T 16553 and relevant testing methods. Color grade, clarity grade, cut grade, and optical performance grade belong to quality grading and shall not be used to infer the synthesis method, process route, or treatment status of the sample. Quality grading results only reflect the visual and craftsmanship level of the synthetic sample itself, and shall not be cross-compared or equivalently claimed with natural diamond quality grades.

4.2 Multi-Evidence Principle

Judgments on species, synthesis attributes, and process tendency shall integrate multiple types of evidence such as macroscopic observation, microscopic observation, conventional physical properties, spectroscopic characteristics, growth structures, surface characteristics, and fluorescence characteristics. Any single parameter, single spectral peak, or single inclusion characteristic shall not be directly used as a decisive conclusion. Grading determination also requires the combination of instrumental data, physical color comparison stones, and color card comparison, and shall not be graded based on a single visual impression alone.

4.3 Traceability Principle

Each result shall be traceable to the sample, equipment, reference materials, color card version, lighting conditions, observation geometry, observer, raw data, reviewer, and method version. Grading results that cannot fully record key conditions shall have their evidence level reduced or be recorded descriptively only.

4.4 Physical Priority Principle

Color grading shall prioritize controlled synthetic diamond physical color comparison stones (synthetic reference samples) as the first priority, followed by the current Pantone FHI TPG physical color card, with instrumental measurement and commercial color names only as auxiliary or descriptive. Paper-based color cards are used to communicate the visual range of colors and are not equivalent to the optical response, fire, transparency, or brightness of diamonds. When synthetic reference samples conflict with TPG color cards, instrumental colorimetric data, or commercial names, the visual result of the synthetic reference sample shall be the final grading basis, and the conflict shall be fully recorded. Original data shall not be modified afterward to force consistency.

4.5 Non-Absolutization Principle

The parameter ranges, thresholds, and candidate color numbers in this document all have明确 applicable varieties, methods, states, cutting directions, and boundary rules. Without verification, parameter ranges shall not be used for binary determination of synthesis processes, TPG color numbers shall not be directly equated with grades, and commercial color names shall not be written as quality grades. All quantitative thresholds are grading references and do not constitute sufficient conditions for natural/synthetic identification.

5 General Testing Conditions (Uniformly Enforced)

5.1 Environmental Conditions

Temperature (20±5)°C, relative humidity 40%~70%, no direct strong light, no environmental color reflection, no airflow disturbance.

5.2 Lighting Conditions

Color grading uses D65 standard simulated daylight source (color temperature 6500K±200K, color rendering index Ra⩾95, illuminance ⩾2000lux); clarity and structure observation uses high color rendering, flicker-free professional jewelry light source.

5.3 Essential Testing Equipment

High-precision electronic balance (0.0001ct), 10× standard magnifying glass, gemstone microscope, ultraviolet fluorescent lamp, refractometer/thermal conductivity meter, spectrophotometer (UV-Vis-NIR), infrared spectrometer (when necessary), diamond proportion meter, cathode ray apparatus or ultra-short wave ultraviolet device (for growth sector observation), photoluminescence spectrometer (when necessary).

5.4 Determination Priority (Color)

Controlled synthetic diamond physical color comparison stone → Current Pantone FHI TPG physical color card → CIELAB instrumental auxiliary data → Commercial color name.

6 Product Classification

Classification Dimension	Category
By synthesis process	HPHT high pressure high temperature laboratory-grown diamond, CVD chemical vapor deposition laboratory-grown diamond
By body color	Colorless laboratory-grown diamond, colored laboratory-grown diamond (yellow, pink, blue, red, green, brown)
By finished product form	Loose stone laboratory-grown diamond, mounted finished product laboratory-grown diamond

7 Testing Methods and Testing Characteristics

7.1 Testing Methods

Implemented in accordance with GB/T 16553—2017, Section 4.1.

7.2 Testing Characteristics

The testing characteristics of laboratory-grown diamonds — chemical composition, luster, cleavage, hardness, density, optical character, refractive index, magnification, fluorescence, luminescence images, and UV-Vis, infrared and photoluminescence spectra — shall follow T/GAC 18—2024 and are not repeated in this document.

For the types of internal and external characteristics, see Appendix A.

7.3 Single Indicator Testing Methods

Testing Item	Method	Judgment Description
Color	Visual comparison under D65 + TPG candidate mapping	Color comparison stone priority; TPG only for auxiliary communication
Clarity	10× magnification + microscopic observation	Six-dimensional evaluation (type/quantity/size/position/visibility/impact)
Cut	Proportion meter + visual	Proportions, symmetry, polish evaluated separately
Weight	High-precision balance	Unit ct, precision 0.0001ct
Process Identification	Microscopy + spectroscopy + fluorescence	Multi-evidence integration, single characteristic conclusion prohibited

8 Quality Grading Rules

8.1 Color Grading

8.1.1 Colorless-Near Colorless Laboratory-Grown Diamonds

Implemented in accordance with GB/T 16554—2017, Section 4.1. Grades are divided into: D, E, F, G, H, I, J, K, L, M and below.

8.1.2 Colored Laboratory-Grown Diamonds (TPG Candidate Mapping Five-Level System)

General Judgment Principles:

Grading is based on the overall, uniform, and stable main hue of the diamond; local color bands, color halos, and slight edge color deviation are ignored; for samples with slight secondary colors (purple tone, orange tone, gray tone, etc.), the main color meeting the standard can correspond to the grade, and secondary colors are noted in the certificate remarks; all color grades are quantitatively determined by combining brightness + saturation dual dimensions; samples at the critical range between two grades are recorded as transitional grades and shall not be rounded.

Observation Method:

Under specified conditions, place the laboratory-grown diamond approximately 25cm from the light source, observe from the crown direction, with visible movement of approximately ±15° (see Appendix B), and evaluate the color of the colored laboratory-grown diamond based on the reflected color.

Five levels in each of six color series:

① Yellow Laboratory-Grown Diamonds (Mainstream HPHT Output)

Grading Level	Color Grading Description
Fancy Light Yellow	Nearly colorless, only weak yellow tone visible under standard strong light, extremely low yellow identification
Fancy Yellow	Primrose yellow, light freesia yellow tone, soft and uniform yellow tone, no heavy feeling

Grading Level	Color Grading Description
Fancy Intense Yellow	Standard pure golden yellow, moderate saturation, uniform and transparent color development
Fancy Deep Yellow	Deep golden yellow, honey yellow tone, rich and full yellow tone, uniform brightness without dullness
Fancy Vivid Yellow	High saturation bright golden yellow, excellent transparency, top-grade vivid yellow

② Pink Laboratory-Grown Diamonds (Mainstream CVD Output)

Grading Level	Color Grading Description
Fancy Light Pink	Extremely weak pink tone, only light pink tone identifiable under D65 strong light
Fancy Pink	Light peach pink, soft pink, light and transparent pink tone, clean without impurities
Fancy Intense Pink	Standard princess pink, balanced saturation, soft and premium visual
Fancy Deep Pink	Deep rose pink, rich and full pink tone, transparent without gray
Fancy Vivid Pink	High saturation bright rose pink, pure hue without impurities, top-grade vivid pink

③ Blue Laboratory-Grown Diamonds (Both HPHT/CVD Can Produce)

Grading Level	Color Grading Description
Fancy Light Blue	Weak ice blue tone, extremely light color under natural light
Fancy Blue	Light sky blue, ice blue tone, fresh and clean without gray
Fancy Intense Blue	Standard sky blue, moderate saturation, uniform color
Fancy Deep Blue	Pure royal blue, rich and full, transparent without dullness
Fancy Vivid Blue	High saturation bright royal blue, bright and eye-catching, top-grade vivid blue

④ Red Laboratory-Grown Diamonds (Rare Color Series, Mostly CVD Output)

Grading Level	Color Grading Description
Fancy Light Red	Weak water red tone, low red identification
Fancy Red	Light water red, light crimson, transparent and soft red tone
Fancy Intense Red	Standard crimson, balanced saturation
Fancy Deep Red	Deep red, vintage rose red, rich and full
Fancy Vivid Red	High saturation true red, pure and bright, top-grade vivid red

⑤ Green Laboratory-Grown Diamonds (Rare Color Series, Mainly CVD)

Grading Level	Color Grading Description
Fancy Light Green	Weak light green tone, only identifiable under strong light
Fancy Green	Light tender green, mint green, fresh and transparent
Fancy Intense Green	Standard grass green, emerald green, pure hue

Grading Level	Color Grading Description
Fancy Deep Green	Deep emerald green, rich and full
Fancy Vivid Green	High saturation bright emerald green, top-grade vivid green

⑥ Brown Laboratory-Grown Diamonds (Mainly HPHT Output)

Grading Level	Color Grading Description
Fancy Light Brown	Light beige brown, light coffee, extremely light brown tone
Fancy Brown	Milk tea brown, light coffee brown, soft and transparent
Fancy Intense Brown	Camel brown, light chocolate brown, uniform and full
Fancy Deep Brown	Deep coffee brown, vintage brown, rich and heavy
Fancy Vivid Brown	Bright red-brown, high saturation, transparent and bright

Important Statement: The Pantone FHI TPG candidate color number range for each level is still under physical approval. Until approval is complete the ranges are not published and shall not be used as a grading basis. Before formal grading, the following must be completed:

1. Controlled synthetic diamond physical color comparison stone valuation;
2. Current Pantone FHI TPG physical color card visual comparison;
3. D65 standard lighting verification (color temperature 6500K±200K, Ra≥95);
4. Specified observation geometry (table up, 0°/45° or integrating sphere);
5. At least 2 independent observers unanimously judge.

8.2 Clarity Grading

Laboratory-grown diamond clarity grading refers to GB/T 23885—2017, evaluated in six dimensions: type, quantity, size, position, visibility, and impact, divided into:

Grade	Judgment Description
LC	No visible inclusions under 10×
VVS1	Extremely difficult to see tiny inclusions under 10×
VVS2	Very difficult to see tiny inclusions under 10×
VS1	Difficult to see a small amount of inclusions under 10×
VS2	A small amount of inclusions visible under 10×
SI1	Inclusions easily visible under 10×
SI2	Inclusions obviously visible under 10×
P (I1-I3)	Inclusions visible to the naked eye, affecting durability or aesthetics

8.3 Cut Grading

Cut and optical performance are evaluated separately:

Cut Dimensions: Proportions (table width ratio, crown angle, pavilion angle, girdle thickness), symmetry, polish quality → divided into five levels: Excellent, Very Good, Good, Fair, Poor.

Optical Performance Dimensions: Brightness, fire, scintillation, transparency, special optical effects (such as asterism) → described and recorded separately.

Cut Types:

Common cut types of laboratory-grown diamonds include: cushion, oval, radiant, pear, heart, marquise, square, emerald, round. Common cut types and cut proportions are shown in Appendix C.

Round Cut: In accordance with GB/T 16554—2017, Chapter 6.

Fancy Cut:

- Measurement items and measurement methods in accordance with GB/T 16554—2017, Section 6.1.
- Symmetry grading in accordance with GB/T 16554—2017, Section 6.3.2.
- Polish grading in accordance with GB/T 16554—2017, Section 6.3.3.

8.4 Carat Weight

In carats (ct), precision 0.0001ct. Weight is the core basic parameter for grading and pricing. Implemented in accordance with GB/T 16554—2017, Chapter 7.

9 Inspection Rules

9.1 Inspection Classification

Factory inspection (routine items) and type inspection (full items, including periodic verification).

9.2 Inspection Items

Category identification, process differentiation, color, clarity, cut, optical performance, carat weight, appearance quality.

9.3 Judgment Rules

- All testing indicators meeting the technical requirements of this standard are qualified products;
- Colored laboratory-grown diamond color grading must implement the "color comparison stone priority → TPG candidate mapping auxiliary" process;
- It is strictly prohibited to automatically grade based solely on a single TCX/TPG color number;
- Process tendency is only recorded with a specific name when evidence is sufficient; otherwise, marked as "process tendency pending verification."

10 Marking Specifications

10.1 Labels and Imprints of Laboratory-Grown Diamonds

The label and imprint content of laboratory-grown diamonds is "LGD" or "SD". For example: LD0.51ct.

10.2 Finished Product Certificate/Label Must Include

Field	Requirement
Sample name	Synthetic diamond/laboratory-grown diamond (specify category)
Synthesis process	HPHT / CVD / Process tendency pending verification
Color grade	Color grading level + corresponding TPG candidate color number approval status
Clarity grade	According to 8.2 grading results
Cut grade	Proportions/symmetry/polish separately or comprehensively marked
Optical performance	Brightness/fire/scintillation description (optional)
Carat weight	Accurate to 0.0001ct
Treatment status	No treatment characteristics detected / Treatment status pending verification
Testing environment	Temperature, humidity, lighting conditions
Traceability information	Testing basis, equipment number, observer, reviewer, date

11 Laboratory-Grown Diamond Certificate

11.1 Basic Content of Laboratory-Grown Diamond Certificate

- Certificate number
- Testing conclusion
- Quality
- Testing basis
- Signature/seal and date

11.2 Other Optional Content

Color, clarity, cut, remarks, etc.

12 Packaging, Transportation, and Storage

12.1 Packaging

Shockproof, moisture-proof, scratch-proof, extrusion-proof special jewelry packaging, individually packaged.

12.2 Transportation

Avoid heavy pressure, severe impact, high temperature exposure, moisture corrosion; ensure protective fixation.

12.3 Storage

Dry, dark, constant temperature (20±5)°C, non-corrosive gas environment, classified storage.

13 Supplementary Provisions

13.1 This standard is a fully quantified, traceable testing and grading standard for synthetic colored precious gems, applicable only to primary artificially synthesized diamonds without post-treatment.

13.2 All optimized treatment samples are outside the scope of this standard's grading.

13.3 TPG color card version iterations do not affect the grading gradient and judgment logic of this standard. The candidate color number mapping table must be re-approved with color card version updates, and approval records shall be included in laboratory quality control files.

13.4 The final interpretation right of this standard belongs to the GDCS Standard Committee.

13.5 Copyright Owner of this standard: Association for Intelligent Diamond International (AIDI).

Appendix A (Informative) Internal and External Characteristic Types of Laboratory-Grown Diamonds

The names, symbols and descriptions of common internal characteristics (pinpoint, cloud, dark inclusion, needle, internal graining, feather, chip, metallic inclusion, extended grown face, cavity) and external characteristics (polish lines, scratch, extra facet, nick, pit, abrasion, burn mark, dop burn, grown face, inscription) shall follow the appendix of T/GAC 18—2024.

Appendix B (Informative) Colored Laboratory-Grown Diamond Color Observation Diagram

The colored laboratory-grown diamond color observation diagram is shown in Figure B.1.

Figure B.1 Colored Laboratory-Grown Diamond Color Observation Diagram

Observation conditions: Place the laboratory-grown diamond approximately 25cm from the light source, observe from the crown direction, with visible movement of approximately ±15°, and evaluate the color of the colored laboratory-grown diamond based on the reflected color.

Appendix C (Informative) Common Cut Types and Cut Proportions of Laboratory-Grown Diamonds

Common cut types include: cushion, radiant, square, heart, pear, marquise, emerald, oval and round. The common length-to-width ratios of each shape shall follow the appendix of T/GAC 18—2024.

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