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Gems testing – Cathode luminescence image method

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Gems testing – Cathode luminescence image method

1 Scope

This Standard specifies the method principle, test method and result representation of cathode luminescence image method for gems testing.

This Standard applies to the testing of gems and their optimizing processed products.

2 Normative references

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

GB/T 16552, *Gems – Nomenclature*

GB/T 16553, *Gems – Testing*

GB/T 17359, *Microbeam analysis – Quantitative analysis using energy dispersive spectrometry*

3 Terms and definitions

For the purposes of this document, the following terms and definitions and those given in GB/T 16552 and GB/T 16553, apply.

3.1

cathodoluminescence

Luminescence generated by high-power electron beams bombarding the surface of an object, which is a type of fluorescence radiation.

3.2

activator

Some elements (valence state elements) will cause cathode luminescence of minerals

after they enters a mineral crystal, such as transitional elements including Mn^{2+}, Fe^{3+}, Ti^{4+}, and lanthanide elements including Eu^{2+}, Eu^{3+}, Sm^{3+}, Dy^{3+} and Tb^{3+}.

3.3

structural defects

Distortions of the periodic potential field in lattice, such as point defects, linear defects, planar defects, body defects, etc. in lattice.

4 Method principle

Gems of different kinds or gems of the same kinds from different origins can generate luminescence of different wavelengths and intensities under the bombardment of high-power electron beams. The colour and distribution characteristics of the luminescence can use used to determine the kinds and contents of some microelements in gems as well as their structural defects. Based on the characteristics such as the crystal structures or growing textures displayed by cathode luminescence images, the information can be known such as the growing environment, growing history, etc. of gems.

5 Cathodoluminescence process

The cathodoluminescence process of gems include:

a) that energy absorption cause the transition of electrons between valence bands and conduction bands as well as additional energy levels, transiting electrons to the excited state;

b) the residence time of electrons in the excited state is about 10^{-9} s ~ 10^{-7} s;

c) electrons in the excited state transits to the ground state through radiation to generate photon emission (luminescence).

6 Major factors influencing cathode luminescence

The major factors influencing cathode include:

a) activating agent: the content, kind and valence state of activating agent, the differences in solid materials attached, etc. influence the colours and intensities of cathode luminescence;

b) structural defects (or self-activation): structural defects and internal stresses

8.2 Matters needing attention

8.2.1 For gem cathode luminescence instruments, the initial high voltage and beam value can be set to 8 kV and 100 μA; adjustments are made based on the luminescence intensity: if sample gives poor luminescence effects, high voltage or beam knobs are adjusted to change the set values of high voltage or beam to achieve the best observation effects.

8.2.2 High voltage and beam values are preferably not adjusted too high. Pay particular attention to the use of sample containing constitution water or organic matters, or showing poor stability, etc. For example: opals, pearls, pink diamonds, high-colour-grade diamonds, fluorites, etc. may have changes in appearance or texture under the exposure to high energy beams.

8.2.3 Pay attention to adjusting the angles of sample; observe from different directions and positions.

8.2.4 Because of observation for a long time, the surface of some samples may be covered by a film caused by sputtering, which can be removed using the abrasive scrubbing method, using a small amount of abrasive paste.

8.2.5 The high-intensity magnetic fields generated by all kinds of electrical equipment may cause beam to deviate; do not leave objects around sample chamber or other electromagnetic interference sources such as mobile phones.

9 Representation of results

9.1 Describe the peculiar colours and structural characteristics observed under cathode luminescence, especially significant characteristics for testing:

a) colour description

Directly use spectrum colours constituting visible light and their secondary colours as well as white, black and colourlessness to describe. Essential colours are in front and secondary colours are in the rear, e.g.: yellow green, green yellow. If necessary, add the descriptions of shade and intensity in front of colours, e.g.: light yellow green, dark green.

b) structure description

In accordance with the luminescence and its distribution characteristics, describe the growing structure, automorphic degree, granular size, shape, inter relations between grains and between grains and matrixes, etc. of minerals constituting gems.

9.2 In accordance with the cathode luminescence characteristics, determine the nature

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