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**Fine ceramics - Test method for crystalline quality of
single-crystal thin film(wafer)using XRD method with parallel
X-ray beam**

精细陶瓷 平行光束X射线衍射法测定单晶薄膜（晶圆）结晶质量

(English Translation)

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Foreword

This document complies with the provisions of GB/T 1.1-2020 "Standardization Work Guidelines Part 1: Structure and Drafting Rules of Standardization Documents".

Drafting.

This document is equivalent to ISO 22278:2020 "Fine ceramics (advanced ceramics, advanced technical ceramics) - Parallel beam X-ray diffraction".

Determining the crystallinity quality of single-crystal thin films (wafers).

The following minimal editorial changes have been made to this document.

---To harmonize with existing standards, the standard name has been changed to "Determination of Single-Crystal Thin Films (Crystallized Particles) by Parallel Beam X-ray Diffraction in Fine Ceramics".

Crystallization quality (round);

---A definition for "phi angle" has been added (see Appendix B);

---Lattice parameter constraints for seven major crystal systems have been added (see Appendix B).

Please note that some content in this document may involve patents. The issuing organization of this document assumes no responsibility for identifying patents.

This document was proposed by the China Building Materials Federation.

This document is under the jurisdiction of the National Technical Committee on Standardization of Industrial Ceramics (SAC/TC194).

Introduction

Single crystals have important applications in many fields, such as synthetic gemstones in jewelry making and laser crystals for solid-state lasers. In some applications...

In this process, ceramic materials are prepared as single crystals. When single crystals are used as substrates for thin film growth, their crystal integrity is crucial, as in the case of sapphire film growth.

Superconducting films are grown on long gallium thin films or single crystals. Wide bandgap semiconductors such as silicon carbide (SiC) and gallium nitride (GaN) are used due to their excellent properties.

(For example, under high critical electric fields, the breakdown voltage is at least 10 times higher than that of silicon or the on-resistance is 100 times lower than that of silicon), which has led to [problems] in electronic applications.

Widespread attention has made it a superior alternative material for future high-power, high-frequency semiconductor devices. In optical applications, single-crystal materials can maximize...

To minimize energy scattering or absorption, materials such as ruby and yttrium aluminum garnet (YAG) are used as laser crystals, and quartz and sapphire are used as optical windows.

Single-domain, single-crystal piezoelectric materials, such as quartz, exhibit optimal performance. Furthermore, the optical, electrical, magnetic, and mechanical properties of ceramic single crystals should also be considered.

It is used in several other fields.

Since the commercialization of wafers in 1990, the diameter of single-crystal wafers has been continuously increasing, and crystal defects have been greatly reduced in the past 15 years.

Commercial devices are already in use, but widespread adoption depends on manufacturers' ability to supply large quantities of inexpensive, defect-free materials.

To date, there are many methods for measuring defects in single-crystal thin films, including methods for measuring the structural defects of large-area (e.g., 2-inch, 4-inch, 6-inch) single-crystal thin films.

The most typical method for assessing crystal quality (average crystal defect rate) is parallel-beam X-ray diffraction (XRD), but this method is prone to errors during operation.

Significant errors are possible. For example, analytical results can vary greatly depending on the user's testing process, conditions, or sample pretreatment; therefore, a [specific method/mechanism] should be developed.

A universally applicable standard for the determination method is essential.

Determination of fine ceramics by parallel beam X-ray diffraction Crystallization quality of single-crystal thin films (wafers)

1 Scope

This document describes a method for determining the crystallinity quality of single-crystal thin films (wafers) using parallel-beam X-ray diffraction.

This document applies to the crystal quality assessment of all single-crystal thin films (wafers) with bulk or epitaxial layer structures using beam X-ray diffraction.

Measurement.

2 Normative references

This document has no normative references.

3 Terms and Definitions

The following terms and definitions apply to this document.

single-crystal

Crystalline materials in which all regions have the same atomic arrangement.

off-cut angle

The angle formed between a specific crystal plane and the surface of a single crystal thin film.

Note: In the epitaxial growth of single-crystal thin films (wafers), the bevel angle is a key factor determining the growth behavior of the thin film.

The chemical action produced by a slurry composed of chemical solutions or abrasive particles, combined with the mechanical action of a grinding machine, makes the sample surface smooth.

The entire process.

Bragg diffraction equation the relationship between the wavelength λ of the incident light, the interplanar spacing d , and the angle θ between the incident light and the diffracting crystal plane.

Note: See formula (1).

$2d \cdot \sin\theta = n \cdot \lambda$ (1) in the formula.

d --- interplanar spacing, in nanometers (nm);

θ --- The angle between the incident ray and the diffraction plane, expressed in degrees (°);

λ --- the wavelength of the incident light, measured in nanometers (nm);