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

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Foreword

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Introduction

Single crystals are important in many applications ranging from synthetic gemstones for jewellery to hosts for solid-state lasers. For some applications, ceramic materials are prepared as single crystals. When used as substrates for thin film growth (such as gallium-on-sapphire technology or the growth of superconductor thin films) it is the crystalline perfection of a single crystal that is important. Wide bandgap semiconductors such as silicon carbide (SiC) and gallium nitride (GaN) have drawn a lot of attention in power applications due to their superior material properties such as high critical electric field resulting in a minimum of 10 times higher breakdown voltage or a 100 times smaller on-resistance than Si. These unique properties of SiC and GaN materials have made them promising candidates for future high-power, high-frequency semiconductor devices. In optical applications, such as the use of ruby and yttrium-aluminium-garnet (YAG) for laser hosts and quartz and sapphire for optical windows, single crystals are used to minimize scattering or absorption of energy. In piezoelectric materials, such as quartz, the optimum properties are obtained in single-domain single crystals. In addition, there are many other applications that require the optical, electrical, magnetic or mechanical properties of ceramic single crystals.

Substrate diameters for the single crystal have been steadily increasing since the commercial introduction of substrates in 1990 and crystal defects have been greatly reduced in the past 15 years. Commercial devices are available, but their widespread use will depend on the ability of growers to make large, inexpensive, defect-free materials available.

While various methods for measuring the defect of single-crystal thin films have been presented until now, the most typical method for measuring the crystalline quality (degree of average defect) of single-crystal thin films that have a wide area (e.g. 2 inches, 4 inches, 6 inches) is the X-ray diffraction (XRD) method with parallel X-ray beam. However, this method can easily create a great error margin as the result value is analysed to be very different depending on the measuring process and conditions of the user or the pre-treatment of samples, for example. A standard on universal measurement methods and conditions, therefore, is absolutely necessary.

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