CURRENT STATUS OF ISO/TC206 FINE CERAMICS

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ABSTRACT

ISO/TC206 is a technical committee (TC) in ISO, which deals with the ISO standards relating to fine (advanced) ceramics. This technical committee was established in 1992, and the first plenary meeting was held in 1994. After more than 20 years of the activities of this TC, we already have around 100 ISO published standards, and still around 40 new work items under development. For the discussion of the standards for this field, we have 12 working groups in our TC. They are (1) terminology/classification, (2) powders, (3) chemical analysis, (4) composites, (5) porous ceramics, (6) monolithic ceramics - mechanical properties, (7) monolithic ceramics - physical and thermal properties, (8) joining, (9) photocatalysis, (10) coatings, (11) electrical and optical applications, (12) engineering applications. In the beginning of this TC, we had work items for fundamental properties on ceramics, such as strength, hardness, thermal expansion etc., but already the discussing items tends to shift to some focused applications, such as bearing balls, photocatalytic materials, piezoelectric materials etc. As the author is in charge of the secretary of this TC, current status of this TC is explained.

INTRODUCTION

ISO TC206 (TC stands for Technical Committee), named 'Fine Ceramics' is a committee in ISO, which deals with international standards, relating to fine (advanced) ceramics. As some domestic standards for evaluating advanced ceramics were discussed and published in the beginning of 1980s, and the international harmonization of the standards were discussed in the beginning of 1990s. In this discussion, ISO/TC206 was established in 1992.

ISO STANDARDS

ISO/TC206 is a technical committee in ISO. ISO has more than 200 technical committees, and they are numbered in the order of their establishment. The latest number of the technical committee is TC 312, Excellence in service. Some of the technical committees already stop their activity. Report on the ISO annual report 2016, ISO has 247 active technical committees.

Table 1 shows the discussing stages for ISO standard documents. Items start from proposal stage, end at publication stage. ISO shows a guideline that from proposal to publication takes 3 years, and the target dates are shown for the stages.

Table 1 Stages for the development of ISO standards

10 Proposal stage	(Ballots for accepting new proposal (**NP**))
20 Preparatory stage	(Discussion in Working Group (WG)) <stage of working draft (**WD**)>
30 Committee stage	(Ballots and Comments in Technical Committee (TC)) <stage of committee draft (**CD**)>
40 Enquiry stage	(Ballots and Comments by ISO participating countries) <stage of draft international standard (**DIS**)>
50 Approval stage	(Final Ballot by ISO participating countries) <stage of final draft international standard (**FDIS**)>
60 Publication stage	(Publication)

ISO/TC206 FINE CERAMICS

TC206 'Fine ceramics' was established in 1992, and the first TC plenary meeting was held in 1994. The title of TC206 was agreed to be 'Fine ceramics', but we have a note, "alternative terms for fine ceramics are advanced ceramics, engineered ceramics, technical ceramics, or high performance ceramics." The Scope of TC206 is as follows;

"Standardization in the field of fine ceramic materials and products in all forms: powders, monoliths, coatings and composites, intended for specific functional applications including mechanical, thermal, chemical, electrical, magnetic, optical and combinations thereof. The term “fine ceramics” is defined as “a highly engineered, high performance, predominantly nonmetallic, inorganic material having specific functional attributes."

So, TC206 includes any form and any application for the ceramics in industrial use.

We have TC206 plenary meeting every year, so, we had 24th meeting in 2017.

Members for technical committee are divided in two groups; Participating members (P-member) and Observer members (O-member). For TC206, we have 16 P-members, Austria (ASI), Belgium (NBN), China (SAC), Czech Republic (UNMZ), France (AFNOR), Germany (DIN), Indonesia (BSN), Ireland (NSAI), Italy (UNI), Japan (JISC), Korea, Republic of (KATS), Malaysia (DSM), Russian Federation (GOST R), Switzerland (SNV), Syrian Arab Republic (SASMO) and United Kingdom (BSI), and 16 O-members, Canada (SCC), Cuba (NC), Egypt (EOS), India (BIS), Iran, Islamic Republic of (ISIRI), Pakistan (PSQCA), Philippines (BPS), Poland (PKN), Romania (ASRO), Serbia (ISS), Singapore (SPRING SG), Slovakia (SOSMT), Spain (AENOR), Thailand (TISI), Turkey (TSE) and Viet Nam (STAMEQ). (Names in the brackets are that of the national standard bodies in the corresponding countries)

PUBLISHED STANDARDS AND DISCUSSING ITEMS IN TC206

As of December 2017, TC206 has 101 published ISO standards. Table 2 shows the titles of the standards, summarized with the responsible working group (WG) in TC206.

Table 2 Published ISO standards from each working group in TC206

Working Group	
ISO standard number (year first published)	ISO standard title Note: Each title is preceded by 'Fine ceramics (advanced ceramics, advanced technical ceramics)'
WG1: Terminology/Classification	
ISO 15165 (2001)	Classification system
ISO 20507 (2003)	Vocabulary
WG2: Powders	
ISO 14629 (2012)	Determination of flowability of ceramic powders
ISO 14703 (2000)	Sample preparation for the determination of particle size distribution of ceramic powders
ISO 17172 (2001)	Determination of compaction properties of ceramic powders
ISO 17860 (2014)	Determination of drying loss of ceramic granules
ISO 18591 (2015)	Determination of compressive strength of ceramic granules
ISO 18753 (2004)	Determination of absolute density of ceramic powders by liquid pycnometer
ISO 18757 (2003)	Determination of specific surface area of ceramic powders by the gas adsorption using the BET method
ISO 23145-1 (2007)	Determination of bulk density of ceramic powders - Part. 1 Tap density
ISO 23145-2 (2012)	Determination of bulk density of ceramic powders: Part. 2 Untapped density
ISO 23245 (2007)	Determination of particle size distribution of ceramic powders by laser diffraction method
ISO 24369 (2005)	Determination of content of coarse particles in ceramic powders by wet sieving method
WG3: Chemical analysis	
ISO 17942 (2014)	Methods for chemical analysis of boron nitride powders

ISO 17947 (2014)	Methods for chemical analysis of fine silicon nitride powders
WG4: Composites	
ISO 14544 (2013)	Mechanical properties of ceramic composites at high temperature - Determination of compression properties
ISO 14754 (2013)	Mechanical properties of ceramic composites at high temperature - Determination of tensile properties
ISO 14603 (2012)	Test method for open hole tension of continuous fibre-reinforced ceramic matrix composites at room temperature
ISO 15733 (2001)	Test method for tensile stress-strain behaviour of continuous fibre-reinforced composites at room temperature
ISO 17138 (2014)	Mechanical properties of ceramic composites at room temperature - Determination of flexural strength
ISO 17139 (2014)	Ceramic composites - Thermophysical properties - Determination of thermal expansion
ISO 17140 (2014)	Mechanical properties of ceramic composites at room temperature - Determination of fatigue properties at constant amplitude
ISO 17142 (2014)	Mechanical properties of ceramic composites at high temperature in air at atmospheric pressure - Determination of fatigue properties at constant amplitude
ISO 17161 (2014)	Ceramic composites - Determination of the degree of misalignment in uniaxial mechanical tests
ISO 18608 (2017)	Mechanical properties of ceramic composites at ambient temperature in air atmospheric pressure - Determination of the resistance to crack propagation by notch sensitivity testing
ISO 18610 (2016)	Mechanical properties of ceramic composites at ambient temperature in air atmospheric pressure - Determination of elastic properties by ultrasonic technique
ISO 19628 (2017)	Thermophysical properties of ceramic composites - Determination of specific heat capacity
ISO 19630 (2017)	Methods of test for reinforcements - Determination of tensile properties of filaments at ambient temperature
ISO 19634 (2017)	Ceramic composites - Notations and symbols
ISO 20504 (2006)	Test method for compressive behaviour of continuous fibre-reinforced composites at ambient temperature
ISO 20505 (2005)	Test method for interlaminar shear strength of continuous fibre-reinforced composites at room temperature by the double-notched test pieces and Iosipescu test
ISO 20506 (2005)	Test method for in-plane shear strength of continuous fibre-reinforced composites at room temperature by the Iosipescu test
WG5: Porous ceramics	
ISO 14610 (2012)	Test method for flexural strength of porous ceramics at room temperature
ISO 17170 (2015)	Test method for sphere indentation of porous ceramics
ISO 28703 (2011)	Test method for thermal shock resistance of porous ceramics
ISO 28704 (2011)	Test method for cyclic bending fatigue of porous ceramics at room temperature
WG6: Monolithic ceramics / mechanical properties	
ISO 14704 (2000)	Test method for flexural strength of monolithic ceramics at room temperature
ISO 14705 (2000)	Test method for hardness of monolithic ceramics at room temperature
ISO 15490 (2000)	Test method for tensile strength of monolithic ceramics at room temperature
ISO 15732 (2003)	Test method for fracture toughness of monolithic ceramics at room temperature by single edge precracked beam (SEPB) method
ISO 17162 (2014)	Mechanical properties of monolithic ceramics at room temperature - Determination of compressive strength
ISO 17561 (2002)	Test method for elastic moduli of monolithic ceramics at room temperature by sonic resonance
ISO 17565 (2003)	Test method for flexural strength of monolithic ceramics at elevated temperatures
ISO 18558 (2015)	Test method for determining elastic modulus and bending strength of ceramic tube and rings
ISO 18576 (2003)	Determination of fracture toughness of monolithic ceramics at room temperature by the surface crack in flexure (SCF) method
ISO 20501 (2003)	Weibull statistics for strength data
ISO 20808 (2004)	Determination of friction and wear characteristics of monolithic ceramics by ball-on-disk

	method
ISO 22214 (2006)	Test method for cyclic bending fatigue of monolithic ceramics at room temperature
ISO 22215 (2006)	Test method for tensile creep of monolithic ceramics
ISO 23146 (2008)	Test methods for determination of fracture toughness of monolithic ceramics – Single edge vee-notch beam (SEVNB) method
ISO 24370 (2005)	Test method for fracture toughness of monolithic ceramics at room temperature by chevron notched beam (CNB) method
WG7: Monolithic ceramics / physical and thermal properties	
ISO 13383-1 (2012)	Microstructural characterisation - Part 1: Determination of Grain Size and Size Distribution (Characterized by the Linear Intercept Method)
ISO 13383-2 (2012)	Microstructural characterisation - Part 2: Determination of phase volume fraction by evaluation of micrographs
ISO 17092 (2005)	Determination of corrosion resistance of monolithic ceramics in acid and alkaline solutions
ISO 17562 (2001)	Test method for linear thermal expansion of monolithic ceramics by push rod technique
ISO 18550 (2016)	Testing method for macro-heterogeneity in microstructure
ISO 18574 (2003)	Determination of density and apparent porosity
ISO 18575 (2005)	Determination of thermal diffusivity of monolithic ceramics by laser flash method
ISO 19618 (2017)	Measurement method for normal spectral emissivity using black body reference with an FTIR spectrometer
ISO 20509 (2003)	Determination of oxidation resistance of non-oxide monolithic ceramics
WG8: Joining	
ISO 13124 (2011)	Test method for interfacial bond strength of ceramic materials
ISO 17095 (2013)	Test method for interfacial bond strength of ceramic materials at elevated temperature
ISO 20407 (2017)	Test method for interfacial tensile and shear fatigue properties of ceramic joining at constant amplitude
WG9: Photocatalysis	
ISO 10676 (2010)	Test method for water purification performance of semiconducting photocatalytic materials by measurement of forming ability of active oxygen
ISO 10677 (2011)	Ultraviolet light source for testing semiconducting photocatalytic materials
ISO 10678 (2010)	Determination of photocatalytic activity of surfaces in aqueous medium by degradation of methylene blue
ISO 13125 (2013)	Test method for antifungal activity of semiconducting photocatalytic materials
ISO 14605 (2013)	Light source for testing semiconducting photocatalytic materials used under indoor lighting environment
ISO 17094 (2014)	Test method for antibacterial performance of semiconducting photocatalytic materials under indoor lighting conditions
ISO 18061 (2014)	Determination of antiviral activity of semiconducting photocatalytic materials - Test method using bacteriophage Q-beta
ISO 18071 (2016)	Determination of antiviral activity of semiconducting photocatalytic materials under indoor lighting environment -Test method using bacteriophage Q-beta
ISO 18560-1 (2014)	Test method for air-purification performance of semiconducting photocatalytic materials by test chamber method under indoor lighting environment - Part 1: Removal of formaldehyde
ISO 19635 (2016)	Test method for antialgal activity of semiconducting photocatalytic materials
ISO 19722 (2017)	Test method for determination of photocatalytic activity by dissolved oxygen consumption
ISO 19810 (2017)	Test method for self-cleaning performance of photocatalytic materials under indoor lighting environment - Measurement of water contact angle
ISO 22197-1 (2016)	Test method for air purification performance of semiconducting photocatalytic materials - Part 1: Removal of nitric oxide
ISO 22197-2 (2011)	Test method for air purification performance of semiconducting photocatalytic materials - Part 2: Removal of acetaldehyde
ISO 22197-3 (2011)	Test method for air-purification performance of semiconducting photocatalytic materials - Part 3: Removal of toluene
ISO 22197-4 (2013)	Test method for air purification performance of semiconducting photocatalytic materials - Part4: Removal of formaldehyde

ISO 22197-5 (2013)	Test method for air purification performance of semiconducting photocatalytic materials - Part 5: Removal of methylmercaptane
ISO 27447 (2009)	Test method for antibacterial activity of semiconducting photocatalytic materials
ISO 27448 (2009)	Test method for self-cleaning performance of semiconducting photocatalytic materials - Measurement of water contact angle
WG10: Coatings	
ISO 14604 (2012)	Methods of test for ceramic coatings - Determination of fracture strain
ISO 17861 (2014)	Measurement method of spectral transmittance of fine ceramics thin films under humid condition
ISO 18452 (2005)	Determination of thickness of ceramic films by contact probe profilometer
ISO 19603 (2016)	Test method for determining elastic modulus and strength of thick ceramic coating
ISO 19606 (2017)	Test method for surface roughness of fine ceramic films by atomic force microscopy
ISO 19674 (2017)	Methods of test for ceramic coatings - Determination of internal stress in ceramic coatings by application of the Stoney formula
ISO 20343 (2017)	Test method for determining elastic modulus of thick ceramic coating at elevated temperature
ISO 20502 (2005)	Determination of adhesion of ceramic coatings by scratch testing
ISO 20508 (2003)	Determination of light transmittance of ceramic thin films with transparent substrates
ISO 26423 (2009)	Determination of coating thickness by crater grinding method
ISO 26424 (2008)	Determination of the abrasion resistance of coatings by a micro-scale abrasion test
ISO 26443 (2008)	Rockwell indentation test for evaluation of adhesion of ceramic coatings
WG11: Electrical and optical applications	
ISO 11894-1 (2013)	Test method for conductivity measurement of ion-conductive fine ceramics – Part 1: Oxide ion conducting solid electrolytes
ISO 17859 (2015)	Measurement method of piezoelectric strain at high electric field
ISO 20351 (2017)	Absolute measurement of internal quantum efficiency of phosphors for white light emitting diodes using an integrating sphere
WG12: Engineering applications	
ISO 14627 (2012)	Test method for fracture resistance of silicon nitride materials for rolling bearing balls at room temperature by indentation fracture (IF) method
ISO 14628 (2012)	Test method for rolling contact fatigue of silicon nitride ceramics at room temperature by balls-on-flat method
ISO 17841 (2015)	Test method for thermal fatigue of fine ceramics substrate
ISO 26602 (2017)	Silicon nitride materials for rolling bearing balls and rollers

In Table 3, ISO numbers are summarized with the published year and the working group for discussion. As you can see, in the beginning of the publication from TC206, we had many items in the field of WG6, that is Monolithic ceramics / mechanical properties. In recent years, we have two big groups of the publications, one is from WG4 Composites, and another is from WG9, Photocatalysis. We can see we have continuous publication items in the field of WG2, Powders, and WG10, Coatings. About the field of applications in WG11 and WG12, we have some recent publications. So, I can say, the published items has the trend that from some evaluation for fundamental properties to some focused applications.

Table 3 Summary of published standards from each working group by the publication year

year	WG1	WG2	WG3	WG4	WG5	WG6	WG7	WG8	WG9	WG10	WG11	WG12	total
2000		14703				14704 14705 15490							4
2001	15165			15733			17562						3
2002						17561							1
2003	20507	18757				15732 17565 20501 18756	18754			20508 20509			9
2004		18753				20808							2
2005		24369		20505 20506		24370	18755 17092			20502 18452			8
2006				20504		22214 22215							3
2007		24235 23145-1							22197-1				3
2008						23146				26443 26424			3
2009									27447 27448	26423		26602	4
2010									10676 10678				2
2011					28704 28703			13124	22197-2 22179-3 10677				6
2012		23145-2 14629		14603	14610		13383-1 13383-2			14604		14627 14628	9
2013				14544 14574				17095	13125 22197-4 22197-5 14605		11894-1		8
2014		17172 17860	17942 17947	17138 17139 17140 17142 17161		17162			17094 18560-1 18061	17861			14
2015		18591			17170	18558					17859	17841	5
2016				18610			18550		18071 19635	19603			5
2017				18608 19634 19628 19630			19618	20407	19810 19722	19674 19606 20343	20351		12

ITEMS IN TC206 UNDER DISCUSSION

Table 4 shows the work items in TC206 under discussion. You can see, about the developing items, many items are in WG4 and WG9, but for other working groups we have some items, so, we have around 40 items to discuss.

Besides these new proposed items, we have so called 'systematic review' of the published items for the confirm/revise/withdraw ballot every five years after the publication. So, some items will go on to revision process, after the agreement that the items shall be revised.

Table 4 New items under discussion in TC206

WG2: Powders	
DIS 19613	Measurement of viscosity of ceramic slurry with rotational viscometer
DIS 20379	Measurement of thixotropic behavior of ceramic slurry with rotational viscometer
WD 21821	Determination of densification properties of ceramic powders on natural sintering
WD 21822	Measurement of isoelectric point of ceramic powder
WG3: Chemical analysis	
WD 21813	Methods for chemical analysis of high purity barium titanate powders
WD 21814	Methods for chemical analysis of aluminum nitride powders
WG4: Composites	
DIS 19604	Mechanical properties of ceramic composites at high temperature - Determination of stress-rupture time diagram under constant tensile loading
DIS 19629	Thermophysical properties of ceramic composites - Determination of unidimensional thermal diffusivity by flash method
DIS 20323	Mechanical properties of ceramic composites at ambient temperature in air atmospheric

	pressure - Determination of tensile properties of tubes
WD 19587	Mechanical properties of ceramic composites at elevated temperature in air atmospheric pressure - Determination of in-plane shear strength
WD TR 20777	Physical properties of ceramic composites -- Guidelines for determination of void and fiber contents in polished cross section by image analysis
WD 21971	Hoop tensile properties of continuous fiber-reinforced ceramic composite tubes at ambient temperature
WD 22459	Reinforcement of Ceramic composites -- Determination of distribution of tensile strength and of tensile strain to failure of filaments within a multifilament tow at ambient temperature
WG6: Monolithic ceramics / mechanical properties	
DIS 21113	Test method for fracture toughness of monolithic ceramic thin plates at room temperature
CD 17167	Mechanical properties of monolithic ceramics at room temperature - Determination of flexural strength by the ring-on-ring test
WD 21618	Test method for fracture resistance of monolithic ceramics at room temperature by indentation fracture (IF) method
WD 21713	Test method for determining elastic modulus of ceramics at high temperature or ultra-high temperature
NP 23242	Test method for flexural strength of monolithic ceramic thin plates at room temperature by three-point or four-point bending
WG7: Monolithic ceramics / physical and thermal properties	
WD 22278	Test method for crystalline quality of silicon carbide (SiC) single crystal using high resolution XRD
WG8: Joining	
WD 21712	Test method for flexural bond strength of ceramics
WG9: Photocatalysis	
DIS 17168-1	Test method for air purification performance of semiconducting photocatalytic materials under indoor lighting environment - Part 1: Removal of nitric oxide
DIS 17168-2	Test method for air purification performance of semiconducting photocatalytic materials under indoor lighting environment - Part 2: Removal of acetaldehyde
DIS 17168-3	Test method for air purification performance of semiconducting photocatalytic materials under indoor lighting environment - Part 3: Removal of toluene
DIS 17168-4	Test method for air purification performance of semiconducting photocatalytic materials under indoor lighting environment - Part 4: Removal of formaldehyde
DIS 17168-5	Test method for air purification performance of semiconducting photocatalytic materials under indoor lighting environment - Part 5: Removal of methyl mercaptan
DIS 19652	Test method of complete decomposition performance by photocatalytic materials under indoor lighting environment - Decomposition of acetaldehyde
DIS 21066	Qualitative and semi-quantitative assessment of the photocatalytic activities of surfaces by the reduction of resazurin in a deposited ink film
WD 19728	Test method for air purification performance of photocatalytic products : Measurement of specific quantum efficiency
WD 22551	Determination of bacterial reduction rate by semiconducting photocatalytic materials under indoor lighting environment -- Semi-dry method for estimating antibacterial activity on the actual environmental bacteria contamination surface
WD 22601	Test method for determination of phenol oxidative decomposition performance of semiconducting photocatalytic materials by total organic carbon analysis
WG10: Coatings	
DIS 21714	Test method for determining density of ceramic coatings
NP 23114	Test method for determining bonding strength of ceramic coatings
WG11: Electrical and optical applications	
DIS 19622	Test method for piezoelectric constant d33 of piezoelectric ceramics by direct quasi-static method
DIS 21819-1	Characteristic of piezoelectric properties under high-load conditions -- Part 1: Resonant-antiresonant method under high temperature conditions
DIS 21819-2	Characteristic of piezoelectric properties under high-load conditions -- Part 2: Electrical transient response method with high vibration levels

WD 21820	Ultraviolet photoluminescence image test method for analyzing polytypes of conductive SiC crystals
WG12: Engineering applications	
WD 21859	Test method for plasma resistance of ceramic components in semiconductor manufacturing equipment
NP 23102	Weibull statistics for strength data of porous ceramics

SUMMARY

ISO/TC206 'Fine ceramics' is a technical committee, for discussing items for standardization in the field of advanced ceramics. We already have 101 published international standards, and more than 30 work items under discussion. The discussing items shift from some measurement of fundamental properties to some properties focused to a specified application. It is more than 15 years after the first ISO publication from this technical committee, so, not only the publication of new items but the maintenance of the published standards with obtaining opinions in the systematic review is also an important job in the technical committee. We need more support by the experts in this field, researchers on ceramic materials.

ISO website, http://www.iso.org/, has a lot of information, include for TC206, so, for some more details, you can access to this website.

** This paper was presented as an invited talk during the 42nd International Conference on Advanced Ceramics and Composites (ICACC 2018), January 28 – February 2, 2018, Daytona Beach Florida (Abstract number ICACC-S11-018-2018). ICACC is organized by the Engineering Ceramics Division of The American Ceramic Society*