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Standard Classification for Advanced Ceramics[1]

This standard is issued under the fixed designation C 1286; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This classification covers a system by which advanced ceramics may be classified. The system has been devised to cover all types of advanced ceramics in the forms of inorganic precursors for ceramic powder production, powders, granular forms, fibers, whiskers, platelets, single crystals, consolidated polycrystalline ceramics, amorphous (glassy) and composite materials, and components in block and coating forms. The structure of the classification system is coded to be machine readable.

1.2 The classification system has been developed through an international collaboration under the auspice of the Versailles Advanced Materials and Standards Project (VAMAS) Technical Working Area 14, and with support from the Commission to the European Communities, ASTM Institute of Standards Research, and the Japan Fine Ceramics Association. Its construction was based on the results of an international survey of requirements among manufacturing and user industries, and recommendations provided at an international workshop held at Ispra, Italy, in June 1990.

1.3 The present range of products that is encompassed by the term *advanced ceramics* or one of its synonyms is enormous in breadth, and complex in chemistry, form, processing route, and property attributes. Normally, there are close interlinks between these factors. It has therefore been impossible to devise a simple hierarchial scheme, such as that used in IEC 672 for electrotechnical ceramics for insulators. The system developed and incorporated in this classification is novel in many respects to encompass all foreseen requirements and purposes, and all raw and manufactured materials and applications. It has great flexibility and is amenable to computer recognition and programming.

1.4 *System Constraints*—It is not the purpose of this classification to specify how the system shall be used. The user is able to define the coding combination and the level of detail to suit a particular purpose. This classification provides only a flexible framework within which this might be done.

1.4.1 The classification system includes only those ceramic products defined and designated by ceramic manufacturers, trade associations, and professional societies as advanced ceramics (see 3.1.1). On this basis, the classification system does not cover:

1.4.1.1 Elemental carbon, except for specific ceramic forms such as diamond, vitreous carbon, and chemical vapor deposit (CVD) graphite;

1.4.1.2 Elemental silicon, elemental germanium, and other elemental or compound semimetallic (intermetallic) substances other than when they form an integral component of, or precursor for, an advanced ceramic;

1.4.1.3 Traditional ceramics based on clay, including: porcelains; whitewares; sanitary wares; floor and wall tiles;

1.4.1.4 Unshaped and shaped refractories and bulk glasses for tonnage applications; and

1.4.1.5 Flat or container glass.

1.4.2 This classification provides a classification system framework that allows comparison and correlation of collected data/information with that gathered under other classification systems, such as the Standard Industrial Classification (SIC) code and the international convention on the Harmonized Commodity Description and Coding System. The SIC is the statistical classification standard underlying all establishment-based U.S. Federal economic statistics classified by industry. The SIC code covers the entire field of economic activities and defines industries in accordance with the composition and structure of the economy. The Harmonized System, an international system designed to standardize commodity classification for all major trading nations, in a relational way is similar to the SIC system.

1.4.3 Currently, advanced ceramics are not represented as a specific code field in either the SIC or the Harmonized System, but are included in other categories where other material classes dominate and in which the advanced ceramics comprise only a small fraction of the end products of the classification.

1.4.4 This standard recognizes the relationship between classification systems, but does not present a detailed crosswalk between individual system fields. This relationship is illustrated by the following examples:

1.4.4.1 In structural applications, advanced ceramic products are found in motor vehicle parts and accessories (SIC 3714), steam, gas, and hydraulic turbines (SIC 3511), motors and generators (SIC 3621), aircraft engines and parts (SIC 3724);

1.4.4.2 In mechanical applications, advanced ceramic products appear in cutting tools (SIC 3545), ball and roller bearings (SIC 3562), pumps and pumping equipment (SIC 3561), and

[1] This classification is under the jurisdiction of ASTM Committee C-28 on Advanced Ceramics and is the direct responsibility of Subcommittee C28.91 on Nomenclature.

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fabricated metal products (SIC 3499); and

1.4.4.3 Applications in electronics are found in electronic capacitors (SIC 3675), semiconductors (SIC 3674), electronic resistors (SIC 3676), and electronic components, not elsewhere classified (SIC 3679).

1.5 For related information, see Reynard,[2] Cotton,[3] Schneider,[4] and *Standard Industrial Classification Manual*.[5]

2. Referenced Documents

2.1 *ASTM Standards:*

C 1145 Terminology of Advanced Ceramics[6]

3. Terminology

3.1 Definitions—For definitions of terms not included here, see Terminology C 1145.

3.1.1 *advanced ceramic*—a highly engineered, high-performance, predominantly nonmetallic, inorganic, ceramic material having specific functional attributes.

3.1.1.1 Discussion—This definition has been adopted by the Versailles Advanced Materials and Standards Project (VAMAS) Technical Work Area 14 on classification of advanced technical ceramics. It is recognized that the specific functional attributes result from the rigorous control of composition, processing, and the detailed regulation of highly refined or characterized raw materials during manufacture. Advanced ceramics are known by several alternate pseudonyms such as advanced technical ceramics, engineered ceramics, fine ceramics, etc.

3.1.2 *classification element*—a single term in a classification field.

3.1.3 *classification field*—a set of terms related to one independent aspect or feature of the classification.

3.1.4 *code*—an alphanumeric string with a prescribed definition in terms of material attributes.

3.1.5 *coding element*—a part of a code from one classification field.

4. Significance and Use

4.1 This classification provides a framework whereby all advanced ceramic products can be classified for a variety of purposes, including commercial statistics, market surveys, R&D expenditures, inventories, billings/invoices, specifications, bar coding, material property databases, etc.

4.2 To describe fully the diversity of ceramic materials in various stages of manufacture, it is essential to link chemical composition, form, processing conditions, material properties, and applications in any required combination. The system allows any full or partial combination of these elements to be employed in any sequence for any desired purpose. The elements are described individually in the following sections. Annex A1 through Annex A5 provide a coding scheme and thesaurus for each classification element of the system. Annex A1 through Annex A4 also give a flowchart for the construction of the code for specific classification elements.

4.3 The user should select from the classification fields those relevant to his requirement, and place these in a prescribed order. Examples of some possible combinations are described in Appendix X1.

5. Basis of Classification

5.1 *Introduction*—Since the intention is to provide a capability for classifying any combination of fields in any sequence appropriate to user needs, each field is separately identified by a unique initial letter code:

A = Application
C = Chemcial character
P = Processing method
D = Property characteristics or data
R = Product origin

Note that the form of the product is closely related to chemistry, and is incorporated in the chemistry code.

5.1.1 For the purposes of computer recognition, a strict sequence of classification elements is not required, but for other purposes, such as manual preparation of trade statistics or material specifications, the sequence of classification elements should be chosen and fixed as preferred.

5.1.2 In the following description of code structures, the variable characters in the code are:

X = any appropriate single upper case letter coding character.
n = any appropriate single numeric coding character.

5.2 *Classification Elements for Application Type*—The coding format for this field is *Annn*. The initial character to denote the start of the *application* string is *A*. This is followed by a three-digit number code as listed in Annex A1 for the application areas. In the list, applications are separated into, initially, a hierarchial series of areas by the principal physical function of the product as defined by:

5.2.1 Electrical insulation;

5.2.2 Electronic/ionic conduction;

5.2.3 Mechanical, including wear, at or near ambient temperature;

5.2.4 Thermal, where dimensional stability at raised temperature, heat insulation, heat conduction, or resistance to thermal shock are the principal application features;

5.2.5 Thermomechanical, where both external mechanical loads and elevated temperatures are involved;

5.2.6 Nuclear, where the component plays either an active or a passive nuclear role;

5.2.7 Optical, where the component plays a functional role as an optical element in reflection, refraction, transmission, or absorption of electromagnetic radiation;

5.2.8 Chemical, including biomedical, where the component is employed for handling melts, chemicals, solutions, or atmospheres because of its resistance to attack by them, and in the case of biomedical materials, a degree of bioinertness;

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[2] Reynard, K. R., "Proceedings of Workshop on Classification of Advanced Ceramics," Ispra, June 1990, Elsevier, London, published in Ceramics International, 1993, 19(1), 1 et seq.

[3] Cotton, J. W., Everill, J. B., "Report to VAMAS TWA14—A Unified Classification System for Advanced Technical Ceramics," British Ceramic Research Ltd Report to VAMAS TWA14, November 1992.

[4] Schneider, S. J., Ed., "Final Report of VAMAS Technical Working Area 14, Classification of Advanced Technical Ceramics," VAMAS Report No. 15, ISSN 1016-21866, July 1993.

[5] *Standard Industrial Classification Manual*, Executive Office of the President, Office of Management and Budget, National Technical Information Service, Springfield, VA, Order No. PB 87-100012, 1987.

[6] *Annual Book of ASTM Standards*, Vol 15.01.

5.2.9 Magnetic, where the component possesses properties allowing a functional magnetic role.

5.2.10 The first digit of the three-digit code is given to correspond to the principal physical function, listed in 5.2.1 through 5.2.9. The subsequent digits are nonhierarchial, and follow the listing in Annex A1.

NOTE 1—It may not always be possible to assign a particular product to one of the listed codes. In such a case, the use of the code representing *other* applications should be employed.

5.3 *Classification Elements for Chemical Character*:

5.3.1 This field contains information relating to chemistry and form, and is identified by the letter C. Annex A2 details the field coding method to describe chemistry and form. Due to the relatively complex chemistry and the likelihood of the presence of a number of compounds and forms, this part of the coding system is required to be particularly versatile. The chemical character code should contain at least three essential items of information:

5.3.1.1 Identifier letter (C);

5.3.1.2 Overall form of the item, that is, powder, fiber, monolithic, etc; and

5.3.1.3 Numerical identification of the chemical formula or material type.

5.3.2 Subsequent coding items may be included to identify the form and chemistry of minor constituents. In these cases the form descriptors also act as separators between related compounds.

5.3.3 *Options for Numerical Codes*:

5.3.3.1 The complexity of the chemistry associated with advanced technical ceramics places a heavy responsibility on the numerical coding system used to describe it. A number of options are given to accommodate chemical formula, individual compounds, form descriptors, and to identify purity and compositional range.

5.3.3.2 The options are based on a four-digit code to denote chemical formula or material type and form. A list of code numbers and associated definitions are given in Annex A2.

5.3.4 *Procedures for the Definition of Chemical Purity or Purity Range*:

5.3.4.1 *Procedure 1*—The inclusion of a fifth digit indicating the quantity of the material defined by the preceding four-digit code. The fifth digit would indicate the mass percentage concentration in accordance with the following:

1 ≤ 1 %
2 > 1%, ≤ 10 %
3 > 10 %, ≤ 30 %
4 > 30 %, ≤ 50 %
5 > 50 %, ≤ 70 %
6 > 70 %, ≤ 90 %
7 > 90 %, ≤ 99 %
8 > 99 %

If the value is undefined or undefinable the character may be omitted.

5.3.4.2 *Procedure 2*—The inclusion of purity or concentration level in parentheses (. . .) following the four-digit code. The use of this option should be governed by a set of rules as follows:

(*1*) The sole presence of a number within the parentheses indicates the % of the material present. For single constituent strings this figure would define the purity level; for multiple items, that is, where the chemical character is described in the long form, this would denote composition.

(*2*) The presence within the parentheses of < or > followed by a number indicates the maximum or minimum content of the constituent. For example, (<90) indicates maximum content 90 % and (>99.9) indicates minimum 99.9 % content (probably used to signify purity).

(*3*) The presence within the parentheses of two numbers separated by a hyphen indicates a range of composition. For example, (95–98.5) indicates that the material contains between 95 and 98.5 % of the constituent in question. In its simplest form the chemical character code would have the following appearance:

CWBnnnn

where WB identifies the material as fiber blanket and nnnn defines its composition. The format for the chemical character coding could however have the appearance:

CEBxxxx7MEyyyy2MBzzzz1

or:

CEBxxxx(>90)MEyyyy(0.5–4.5)MBzzzz(0.5)

This would indicate that the material was a powder (<100μ diameter) of a compound xxxx (90–99 %) physically mixed (ME) with a chemical compound of yyyy (1–10 %) and zzzz (<1 %).

5.4 *Classification Elements for Processing Method*—The initial character indicating *process* type is *P*. It is followed by a two-digit numerical code selected from the semi-hierarchial list given in Annex A3. Each of the codes represents a description of a single process at a particular stage in the manufacture of a product. If more than one identifiable process is needed to classify a product, the process code is repeated as required:

PnnnPnnnPnnn . . . . . .

5.5 *Classification Elements for Property Characteristics or Data*—Many ceramic products are developed for specific property attributes appropriate to particular end uses. If it is required to provide a classification element to define the *properties* or *characteristics*, this is done using a code with an initial letter *D* (data). This is followed by a string of 3 to 6 numerical characters defined according to the matrix in Annex A4. The first of the numerical characters defines the property class, the second and third defines the property type within that class. The fourth and subsequent characters identify either a value class for the property when measured in accordance with a specified test procedure. If the particular generic property feature cannot be classified in a consistent or well-recognized numerical form, but is a material attribute, this is indicated by using only the first three characters.

5.5.1 If more than one property characteristic is required, the code D is repeated, that is, DnnnDnnnnnDnnn. . . . . represents three property features of particular relevance.

NOTE 2—It is envisaged that property classification elements could be replaced by a more-detailed data base when this is desired, the other classification elements being employed to define uniquely the ceramic product application chemistry, processing, and any other feature of the material or component. *The property measurements used for the classification system, shall wherever possible, be measured and reported in*

accordance with approved national or international standards.

5.6 *Classification Elements for Product Origin*:

5.6.1 This field is uniquely identified by the initial letter R. The field is intended to identify the place and date of product manufacture, as defined by codes listed in Annex A5.

5.6.2 The code for the place of manufacture is based on the international telephone code and consists of a country and city (or local region) numeric identifier string. The date of manufacture is identified by a 2-digit number corresponding to the month (January = 01; December = 12) and by a 4-digit number correspondidng to the year (19yy; 20yy).

5.6.3 The coding format for this descriptor will be:

Rnnnnbbbbxxyyyy

where nnnn is the country code, bbbb is the local area code, xx is the month code, and yyyy is the year code.

5.7 *Other Classification Fields*:

5.7.1 While not included as a part of this classification, additional classification elements may be employed for further features associated with a product as required by the application of the classification, for example, manufacturer name, date of entry of information, statistical data by category, applicable test methods, related other classification codes, etc. If it is desired to include such information, the classification elements should be constructed from agreed tables of codes in the following form:

Xnnn

where X is a unique initial classification field character, and nnn is a three-digit code from the agreed table. In this form, the additional classification elements remain unique and machine readable.

6. Use of the Classification System

6.1 *Introduction*:

6.1.1 The classification system in its entirety represents a fairly complex matrix, the size of which, if the system is used in its entirety, would be unattractive from the user's point of view.

6.1.2 The system has been designed to accommodate all likely inputs in each of the prescribed fields. It is recognized, however, that it is unlikely that the classification system will be used at this level. It is envisaged that:

6.1.2.1 Only a limited number of fields will be used, hence the field identifiers should be readily recognized.

6.1.2.2 Within those fields the information used may be limited to only a few items, hence the order of information should be logical.

6.1.2.3 With use, the regularly encountered items such as specific chemical types will become familiar, hence sectors of the code, such as chemical character, should scan easily.

6.1.2.4 For ease of use, coding lists should be accessible by both item and code.

6.2 *Examples*—Appendix X1 provides examples that are intended to illustrate some of the ways in which the classification system may be used to describe a range of materials and applications.

7. Keywords

7.1 advanced ceramics; advanced ceramic applications; advanced ceramic classification; advanced ceramic database

ANNEXES

(Mandatory Information)

A1. APPLICATION CLASSIFICATION FIELDS

A1.1 This field is uniquely identified by the initial letter *A*.

A1.2 The classification list for applications of advanced technical ceramics is given in Table A1.1. The list is composed of a hierarchy of application types grouped as follows. To assist in the identification of the appropriate class and code as determined by its principal function, an alphabetical index is given in Table A1.2.

NOTE A1.1—Since the application range for advanced ceramic products is widening rapidly, this list may not include recently developed applications. Until the classification is updated, the most appropriate *other* identification should be employed where there is any doubt.

Code No	Application type
100 to 199	Passive electrical applications
200 to 299	Active electrical applications
300 to 499	Mechanical applications
500 to 599	Thermal and thermomechanical applications
600 to 699	Nuclear applications
700 to 799	Optical applications
800 to 899	Chemical applications, including biomedical applications
900 to 949	Magnetic applications
950 to 999	Other applications

A1.3 Some applications may not appear to fall uniquely into a single category listed above by virtue of employing several advantageous features. An example would be chemical plant pump rotating shaft seal. This performs a mechanical function in a chemical environment and is listed under mechanical applications. An index is provided to assist location in the list.

A1.4 A flowchart for construction of the code for applications, which is to be used in conjunction with this annex, is shown in Fig. A1.1.

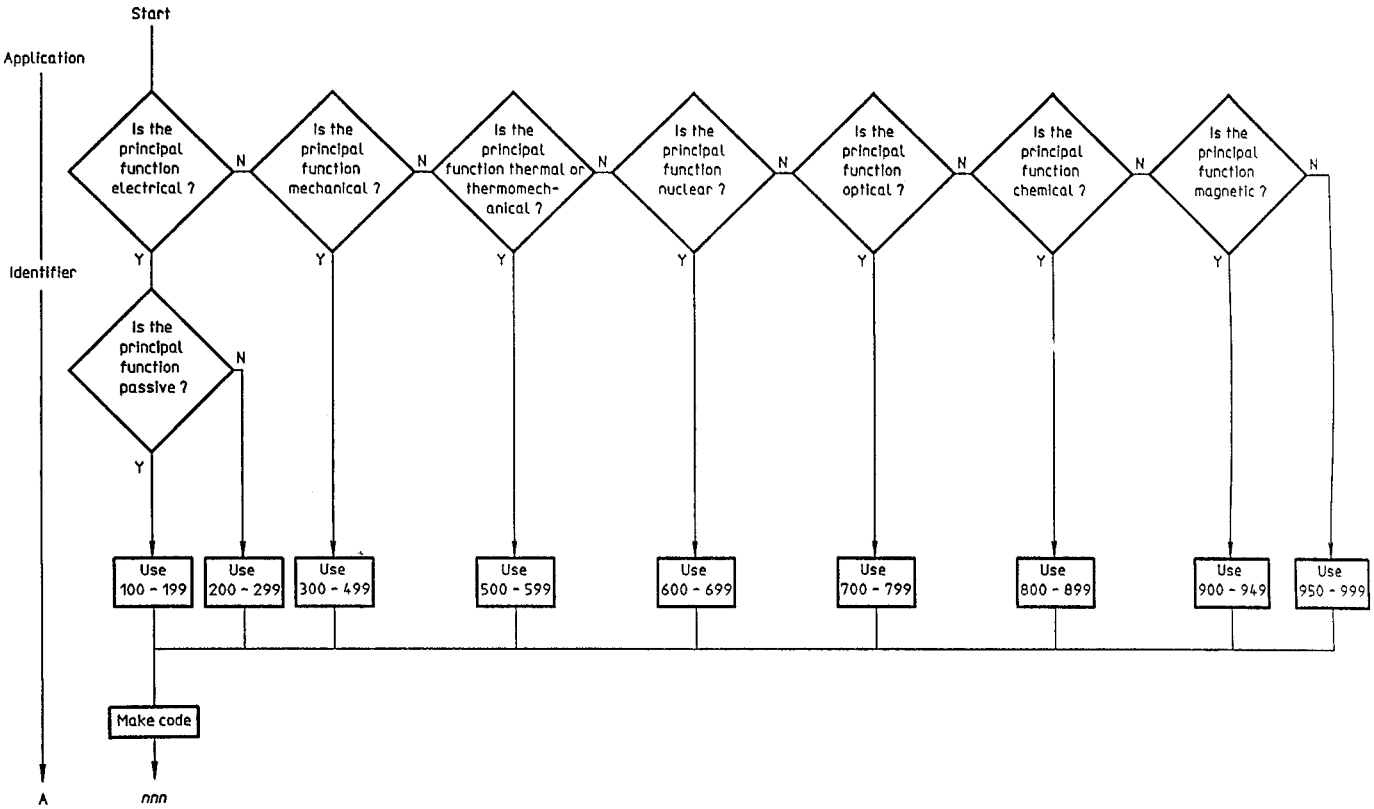

FIG. A1.1 Flowchart for Construction of the Code for Applications

TABLE A1.1 Classes of Applications

100 to 199 Passive Electrical Applications	
Power insulators:	
101	Structural electrical power insulators
102	Small low-tension electrical insulators (for example, standoff insulators, bus bar supports, terminal blocks)
103	Spark plug insulators
104	Igniter insulators
105	Glow plug insulators
106	Eyelets and cable cleats
107	Bushes, sleeves—up to 200°C
108	Bushes, sleeves—above 200°C
109	Aerial insulators
110	Low-power coil formers
111	High-power coil formers
112	Precision coil formers
113	Coil formers for high-frequency applications
114	Coil formers for high-temperature applications
115	Low-power fuse bodies
116	High-power fuse bodies
117	Vacuum envelopes
118	Vacuum leadthroughs
119	Electrical insulators for use in vacuum
120	Other electrical components for use in vacuum
139	Other power electrical insulators
Insulators for electronics:	
140	Substrates for electronic components, monolithic, including pin-grid arrays
141	Multilayer interconnects for electronic circuits, including pin-grid arrays
142	Heat sinks
143	Power semiconductor housings
144	Resistor cores
169	Other electronic packaging applications
Microwave insulators:	
170	Radomes and missile nosecones
171	Windows for use in microwave devices
172	Absorbers and attenuators for microwave devices
173	Phase shifters for use in microwave devices
174	Other applications in microwave devices
199	Other passive electrical applications
200 to 299 Active Electrical Application	
Ohmic electrical conductors:	
201	Ohmic heating elements
202	High-frequency susceptors
203	Electrodes
204	Igniters, jet engine
219	Other ohmic electrical conducting applications
Ionic conductors:	
220	Battery electrolytes
221	Fuel cell electrolytes
222	Gas detectors
223	Exhaust oxygen sensors
224	Molten metal oxygen sensors
229	Other ionic conducting applications
Capacitor applications:	
230	Monolithic single-layer capacitors
231	Multilayer chip capacitors
239	Other capacitors
Non-ohmic electrical conductors:	
240	Varistors
241	Thermistors
242	Attenuators
243	Applications based on superconducting ceramic components
249	Other non-ohmic electrical conductors
Piezoelectric applications:	
250	Microphone membranes, including telephone handsets
251	Loudspeaker membranes, including telephone handsets
252	Other buzzers and vibrators
253	Force, pressure, and acceleration transducers
254	Sonar emitters and detectors
255	Impact igniters
256	Mechanical actuators
257	Motor elements

TABLE A1.1 *Continued*

258	Ink-jet printer heads
259	Resonators
269	Other piezoelectric devices
270	Electrostrictive devices
280	Pyroelectric devices
299	Other functional electrical devices
	300–499 Mechanical Applications
Milling and crushing machinery:	
301	Mill linings
302	Milling media
303	Other mill parts
304	Pestle and mortar linings for grinding soft materials
305	Pestle and mortar linings for grinding hard materials
309	Other milling or crushing applications
Agricultural applications:	
310	Agricultural implements for soil working
311	Agricultural pulverising nozzles
319	Other agricultural applications
Wear-resistant facings for plant and machinery:	
320	Shot blast nozzles
321	Pipelines and cyclones
322	Chute linings
323	Food processing applications
324	Mould and die liners
325	Crushing rolls
326	Slideways, wear-resisting pads
329	Other wear-resistant facings
Ballistic applications:	
330	Ballistic armour
331	Ballistic projectiles
339	Other ballistic applications
Material cutting applications:	
340	Indexable inserts for cutting and machining of hard alloys
341	Indexable inserts for cutting and machining ferrous metals
342	Indexable inserts for cutting and machining nonferrous metals
343	Inserts for rock drilling
344	Paper, tape-cutting knives
345	Domestic knives
346	Scissors and shears
347	Tool dressing components
359	Other material cutting applications
Material shaping applications:	
360	Cold die parts
361	Extrusion and drawing dies
362	Wire drawing cones
363	Dies for hot processes
364	Stamping dies and roller dies
369	Other material shaping applications
Pump applications:	
370	Vanes and impellers for pumps
371	Rotating shaft seals (stationary or rotating components)
372	Hydraulic plungers and cylinders
373	Pump bearing sleeves
374	Pump shafts
375	Pump housings
379	Other pump applications
Valve and tap (faucet) applications:	
380	Tap (faucet) valve faces, single-lever action
381	Tap (faucet) valve faces, multiple-lever action
382	Tap (faucet) valves, for water, other
383	Pneumatic valves
399	Other valve facings for noncorroding liquids
Guides for thread, paper, tape, etc.:	
400	Thread spinning nozzles
401	Friction disks for thread texturing
402	Thread guides
403	Guides, runners for paper handling
404	Applications in printer heads
405	Guides and other components for magnetic tape transport
419	Other thread, paper, or tape guide applications
Bearing applications:	
420	Plain bearing sets
421	Roller bearing sets
422	Precision balls for bearings
423	Precision rollers for bearings

TABLE A1.1 *Continued*

424	Thrust bearing sets
439	Other bearing applications
Precision jigs and metrological devices:	
440	Sizing rings
441	Gage blocks
442	Jigs
443	Vee blocks
444	Surface plates and angle plates
459	Other precision tooling applications
Sport goods:	
460	Shoe studs
461	Golf-club inserts
462	Fishing-rod ring liners
463	Ice-skate blades
469	Other applications in sports goods
499	Other mechanical applications
	500 to 599 Thermal and Thermomechanical Applications
Temperature-resistant electrical applications:	
501	Thermocouple insulators and sheaths
502	Coiled wire heating element supports
503	Supports for rod heating elements
504	Insulators for lamp elements
505	Resistance thermometer element bases
506	Lamp holders
509	Other temperature-resistant electrical applications
High-temperature materials processing applications:	
510	Applications in hot metal immersion probes
511	Muffle tubes for furnaces
512	Saggars for material processing
513	Kiln furniture (ware support) for high-temperature processing
514	Pins for refractory insulation
515	Furnace rollers, runners, and guides
516	Burner parts
517	High-duty heat exchangers
518	Low-duty heat exchangers
519	High-temperature gas valves
520	Weld pool rings
521	Welding nozzles
522	Welding jigs
523	Casting tubes for molten metals
524	Shell moulds
525	Casting cores
526	Filters for liquid metals
527	Break rings for the continuous casting process
528	Crucibles for metal melting and handling
529	Other liquid-metal handling applications
539	Other high-temperature materials processing applications
Aerospace applications:	
540	Rocket nozzles
541	Ablation shields
542	Jet engine petals/nozzles
543	Brake disks
549	Other aerospace applications
Domestic applications:	
550	Domestic cooker tops
551	Cookware
559	Other domestic applications
Reciprocating engine applications:[A]	
560	Cylinder blocks in reciprocating engines
561	Pistons and piston crowns in reciprocating engines
562	Fuel injector nozzles for reciprocating engines
563	Precombustion chambers for reciprocating engines
564	Piston pins
565	Applications in exhaust valves
566	Cam followers
567	Cylinder liners
568	Exhaust port liners
569	Exhaust pipe liners
570	Turbocharger rotors
571	Turbocharger stators
572	Turbocharger housing
573	Fuel injection pins
574	Diesel particulate filters
579	Other reciprocating engine applications
Applications in turbine engines:	

TABLE A1.1 *Continued*

580	Rotors and blades for gas turbines
581	Stators for gas turbines
582	Combustion chambers for gas turbine application
583	Fuel injectors for gas turbines
584	Regenerators and heat-exchanger components for gas turbines
585	Thermal barrier coating of metallic components
586	Shrouds and shroud components
589	Other gas turbine applications
599	Other thermal and thermomechanical applications
	600 to 699 Nuclear Applications
601	Nuclear fuel elements
602	Element separators in nuclear applications
603	Moderators in nuclear applications
699	Other nuclear applications
	700 to 799 Optical Applications
Reflective applications:	
701	Telescope mirrors
702	Synchrotron mirrors
709	Other reflective applications
Non-optical structural components for optical systems:	
710	Optical benches
711	Ferrules for fiber optics
719	Other structural components for optical applications
Laser components:	
720	Laser waveguides
721	Laser rods
729	Other components for lasers
Optical window applications:	
730	Windows for optical wavelengths
731	Windows for infrared wavelengths
739	Other optical window applications
Lamp envelopes:	
740	High-power lamp envelopes
741	Envelopes for high-pressure sodium vapor lamps
749	Other lamp envelopes
Active optical components:	
750	Optical modulators
759	Other active optical components
799	Other optical applications
	800 to 899 Chemical and Biomedical Applications
Laboratory chemical equipment:	
801	Crucibles and boats for laboratory use
802	Funnels for laboratory use
803	Filter media for laboratory use
809	Other laboratory ware applications
Chemical plant applications:	
810	Tower packing in large-scale chemical plant
811	Vessels and pipes in large-scale chemical plant
812	Floats and tubes in large-scale chemical plant
813	Ball valves in large-scale chemical plant
814	Flowmeter applications
815	Gas percolation elements
819	Other chemical plant applications
Chemical moulding parts:	
820	Rubber dipping formers
829	Other mould components
Filter bodies and materials:[B]	
830	Filter elements for liquid media, monolithic
831	Filter elements for gaseous media, monolithic
832	Ceramic filter membranes
839	Other filter applications
Catalysts and catalyst supports:	
840	Ceramic catalysts
841	Catalyst supports, granular
842	Catalyst supports, plate
843	Catalyst supports, monolithic honeycomb, including vehicle exhaust applications
849	Other chemical applications
Biomedical applications:	
861	Orthopedic biomedical implants
862	Dental implants
863	Vascular biomedical implants

TABLE A1.1 *Continued*

899	Other biomedical implants
	900 to 949 Magnetic applications
901	Cores for loudspeakers and microphones
902	Components for transducers
903	Components for microwave devices
904	Components for coils
905	Components for yokes
906	Components in flyback transformers
907	Components for data recording heads
908	Nonmagnetic components for data recording heads
909	Magnets for motors
949	Other magnetic applications
	950 to 999 Other Applications[C]

[A] See 843 for vehicle exhaust catalyst supports.
[B] Filters for molten metals are coded 526.
[C] In the formulation of this coding scheme the codes 950–999 are available for other applications to be identified by user demand.

TABLE A1.2 Alphabetical Index to Applications Classification

TABLE A1.2 *Continued*

TABLE A1.2 *Continued*

TABLE A1.2 *Continued*

Heating elements, ohmic	201
Heating element supports	
coiled wire	502
rods	503
Heat sinks, electronic	142
High-temperature processing	510–539
kiln furniture	513
saggars	512
Honeycomb catalyst supports	843
Housings	
power semiconductor	143
pumps	375
turbochargers	572
Hydraulic cylinders	372
Hydraulic plungers	372
Hydrophones	252
Ice-skate blades	463
Igniter insulators	104
Igniters, impact	255
jet engine	204
Immersion probes, hot metal	510
Impact igniters	253
Impellers	370
Implants	
biomedical	851–899
dental	852
miscellaneous	899
orthopedic	851
vascular	853
Indexable inserts, machine tools	340–342
Ink-jet printer heads	258
Inserts, rock drilling	343
Insulation, refractory pins for	514
Insulators, electrical	
aerials	109
fuse bodies	115–116
glow plug	105
igniter	104
lamp elements	504
low tension, small	102
spark plug	103
structural power, large	101
thermocouples	501
vacuum envelopes	117
vacuum leadthroughs	118
vacuum, use in (degassable)	119
Ionic conductors	220–229
Jet engines (see also Gas turbines)	
nozzles	542
petals	542
Jigs	442
Kiln furniture	513
Knives	
domestic	345
paper cutting	344
tape cutting	344
Laboratory ware	801–809
miscellaneous	809
Lamp elements, insulators	504
Lamp envelopes	
high power	740
high pressure sodium vapor	741
miscellaneous	749
Lamp holders	506
Lasers	
components for	720–729
waveguides	720
Liners, linings	
chutes	322
cyclones	321
cylinder	567
dies	324

TABLE A1.2 *Continued*

exhaust pipe	569
exhaust port	568
mills	301
moulds	324
pestle-and-mortar, for grinding soft materials	304
pestle-and-mortar, for grinding hard materials	305
pipes	321
process plant	321
Loudspeakers	
magnetic cores for	901
piezoelectric membranes for	251
Machine tools	
indexable inserts for	340–342
slideways	326
Magnetic applications	900–949
loudspeaker cores	901
microphone cores	901
miscellaneous	949
Magnetic tape, guides	405
Mechanical actuators	256
Mechanical applications	300–499
miscellaneous	499
Metallic components, thermal barrier coatings for	585
Metals, liquid, handling	523–529
casting tubes for	523
miscellaneous	529
Microphones	
magnetic cores for	901
piezoelectric membranes for	250
Microwave devices	
absorbers	172
attenuators	172
magnetic components or	903
miscellaneous	179
phase shifters	173
windows	171
Milling media	302
Mills	
linings	301
miscellaneous parts for	303
Mirrors	
synchrotron	702
telescope	701
Missile nosecones	170
Moderators, nuclear	602
Modulators, optical	750
Mortar linings, for grinding	304–305
Motors, parts for	
magnets	909
piezoelectric elements	257
Moulds	
liners	324
miscellaneous, chemical applications	829
rubber dipping formers	820
shell	524
Non-ohmic conductors, miscellaneous	249
Nozzles	
agricultural	311
fuel injection	532
fuel injection, control pins for	572
jet engines	542
rockets	540
shot or grit blast	320
thread spinning	400
welding	521
Nuclear applications	600–699
miscellaneous	699
Nuclear fuel elements	601
Optical applications	700–799

TABLE A1.2 *Continued*

TABLE A1.2 *Continued*

Welding nozzles	521
Windows	
infrared wavelengths	731
microwave devices	171
miscellaneous	739
optical	730
Wire drawing	
cones	362
dies	361
Yokes, magnetic components	905

A2. CHEMICAL CHARACTER DESCRIPTOR FIELDS

A2.1 Introduction

A2.1.1 This field contains information relating to chemistry and form, and is uniquely identified by the letter *C*.

A2.1.2 Due to the relatively complex chemistry of advanced technical ceramics and the likelihood of the presence of a number of compounds and forms, this part of the classification system is required to be particularly versatile. The chemical character code contains at least three essential items of information in the following order:

A2.1.2.1 The initial identifier letter *C*;

A2.1.2.2 The overall form of the item, that is, powder, fiber, monolithic, composite, etc., expressed as one or two upper case letters; and

A2.1.2.3 A numerical identification of the chemical formula (of the major constituent at least).

A2.1.3 Subsequent classification items may be included in the coding string to identify the purity of the major component, and the form and chemistry of minor constituents. In these cases the form descriptors also act as separators between related compounds.

A2.1.4 A flowchart for construction of the code for chemical character, which is to be used in conjunction with this annex, is shown in Fig. A2.1.

A2.2 Form

A2.2.1 The form descriptors, which also act as separators in the chemical character coding, are given in Table A2.1.

A2.3 Four-Digit Codes for Simple Chemical Compounds

A2.3.1 Table A2.2 gives a four-digit code to be used for the description of chemical components of precursors, powders, and ceramic products where composition in simple chemical compound form is to be described. Table A2.2 lists the most common metal ions, including those of variable valency, and nine commonly met simple radicals. Individual codes are obtained by combining the metal ion of appropriate valency from the list on the left-hand side of the table with the required radical given at the top of the table. Each combination of metal ion and radical is identified by a unique number. The four-digit codes are arranged in accordance with the following heirarchy:

Code Number	Radical
0001 to 0099	Elements
0101 to 0199	Boride
0201 to 0299	Carbide
0301 to 0399	Nitride
0401 to 0499	Oxide
0501 to 0599	Fluoride
0601 to 0699	Silicide
0701 to 0799	Phosphide
0801 to 0899	Sulphide
0901 to 0999	Iodide

A2.3.2 In the majority of cases requiring classification by detailed chemistry it will be possible to describe an advanced technical ceramic material in terms of these codes. However, the list is not exclusive, and the metal ion description *other* may be used for metallic species not appearing in Table A2.2. For single-species anions not appearing in the table, refer to four-digit codes 1000 to 1999, for two-species of anion see Codes 2000 to 2999, and for more complex compounds see Codes 3000 to 3999.

A2.3.3 It is apparent from the matrix of codes for simple binary compounds that many of the possible code numbers will be rarely used; indeed several of the codes are redundant through impossible combinations, for example, carbon carbide, or through thermodynamic considerations (instability).

A2.3.4 For atomic species that exist wth more than one valency separate rows are provided in the matrix for each valency state. In this way the matrix can provide codes that differentiate between, for example, CeO_2 and Ce_2O_3, or FeO and Fe_2O_3. In some cases, employing simple valencies is not possible. In such cases the formula is quoted after the code number in Table A2.2, but would not be employed in the use of the code. In other cases, a series of two or more compounds may be formed from the same species. This classification does not attempt to separate them with individual codes, but represents them either in the form A_xB_y or in the form AB_y.

A2.3.5 If the component is not normally solid at ambient temperature this is noted in the matrix table (Table A2.2) as (g) for gaseous, (l) for liquid. If the chemical normally has water of crystallisation that would be removed in forming a ceramic product, this is indicated by (h) (for hydrated).

A2.3.6 Substoichiometry of compounds is accommodated in one of two ways:

A2.3.6.1 By the inclusion of a leading character (*N* for nonstoichiometric) in the code. *N* does not appear as a character in the form descriptor, and therefore would not be

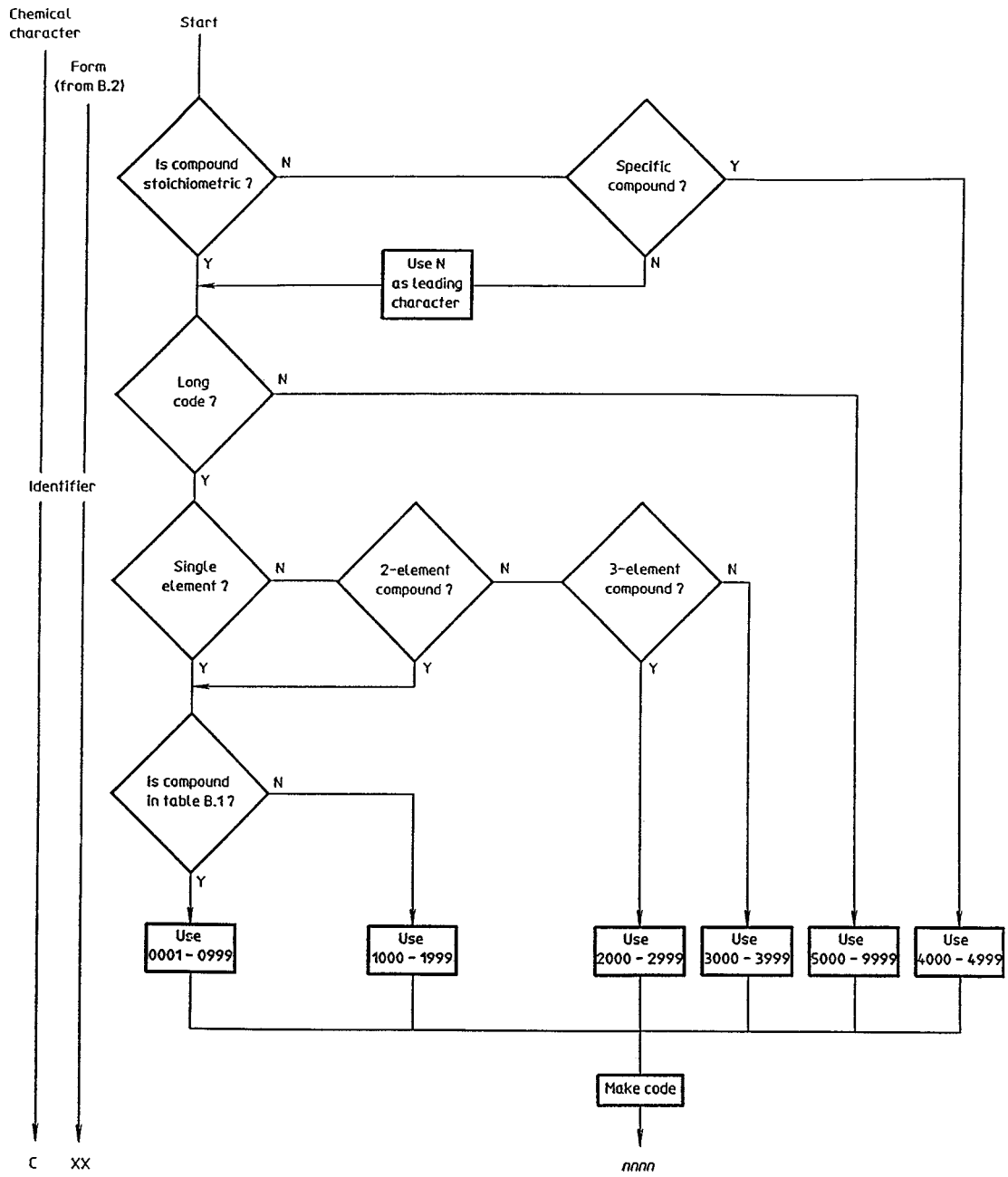

FIG. A2.1 Flowchart for Construction of the Code for Chemical Character

confused with data in that field. The code for a nonstoichiometric titanium dioxide for example would be N0420.

A2.3.6.2 As a designated item in the Code Band 4000 to 4999.

TABLE A2.1 Form Descriptors[A,B]

B =Precursor
- BG = gas
- BL = liquid
- BS = solid

E =Powder
- EE = conventional
- EF = powder-coated with an inorganic material
- EG = powder-coated with an organic material
- EH = spray-dried powder granules
- EJ = mechanically granulated powder
- EK = partly consolidated ceramic/preform/green shape

W =Whisker
- WB = whisker mat
- WE = floated/sized whiskers

F =Fibers
- FS = short, thin fibers
- FL = single, long, thin (continuous) fibers
- FF = filament (thick fibers)
- FT = long fiber tows
- FW = woven fiber mat
- FP = pre-preg
- FB = blanket
- FV = rigid-pressed or vacuum-formed preform or board

K =Monolithic
- KB = solid ceramic object (no deliberate porosity)
- KE = 3D closed cellular ceramic
- KF = 2D cellular ceramic
- KG = open porous ceramic
- KH = graded density (open-porosity) ceramic
- KJ = functionally graded material
- KK = coated ceramic
- KL = surface-treated or surface-modified ceramic
- KM = multilayer composite ceramic
- KS = undirectional (1D) ceramic matrix long-fiber composite
- KT = bidirectional (2D) ceramic matrix long-fiber composite (including woven fibers)
- KU = multidirectional (3D and high) ceramic matrix long-fiber composite (including knitted fibers)
- KV = short (chopped) fiber ceramic matrix composite
- KW = ceramic matrix whisker—containing composite
- KX = ceramic matrix platelet—containing composite
- KY = glass
- KZ = glass-ceramic

L =Ceramic coating
- LB = thin (<20 μm) coating
- LE = thick (≥20 μm) coating
- LF = cementitious material for joining

S =Single crystal

J =Platelets

H =Hollow spheres

M =Mixture (used for second and subsequent species to indicate relationship to first species)
- MB = chemical mixture of a second or subsequent species with the previous one(s) to indicate a compound or solid solution not specifically listed in the chemistry listing (for example, a solid solution of magnesium ditatanate and aluminum titanate)—the code indicates that the following numerical code element refers to a declared second additional compound chemically combined with the previous one
- ME = physical or chemical mixture of a second or subsequent deliberate minor or trace addition to the previously defined compound (for example, MgO in alumina or B in SiC), the exact form or nature of which is not specifically identified.
- MG = physically discrete, nominally continuous second phase in a material composing principally the previously cited phases
- MH = following species in the form of discrete fibers
- MJ = following species in the form of discrete whiskers
- MK = following species in the form of discrete platelets
- ML = following species in the form of a coating on the previous species
- MM = following species is employed in chemically altering the surface of a material relative to its bulk
- MS = following species is employed as a distinct layer in a layer composite

[A]When describing ceramic matrix composites, the matrix phase(s) must be defined first.

[B]All particulate—containing ceramic bodies, including metal and ceramic particles, where the particles form a discrete second phase that might be considered to strengthen or toughen the matrix, are described by codes KB–KZ in accordance with the form of the product. There is no separate code for particulate reinforcement.

TABLE A2.2 Four-Digit Chemical Species Codes for Elements and Simple Compounds

Metal ion	Element	Boride	Carbide	Nitride	Oxide	Fluoride	Silicide	Phosphide	Sulphide	Iodide
Li	0001	0101 Li_xB_y	0201 Li_2C_2	0301	0401	0501	0601	0701	0801	0901
Be	0002	0102 Be_xB_y	0202 Be_2C	0302	0402	0502	x	x	0802 BeS	0902
B	0003	x	0203 B_xC_y	0303	0403	0503 (g)	0603 B_xSi	0703	0803	0903
C	0004	x	x	x	0404 CO_x(g)	0504	x	x	0804 C_xS	0904
Na	0005	0105 NaB_y	0205 Na_2C_2	0305	0405	0505	x	0705	0805 Na_xS_y	0905

TABLE A2.2 *Continued*

Metal ion	Element	Boride	Carbide	Nitride	Oxide	Fluoride	Silicide	Phosphide	Sulphide	Iodide
Mg	0006	0106 $MgB_{2;4}$	0206	0306	0406	0506	0606 Mg_xSi_y	x	0806	0906
Al	0007	0107 Al_xB_y	0207	0307	0407	0507	x	0707	0807	0907
Si	0008	0108 Si_xB_y	0208	0308	0408	0508 (g)	x	x	0808 Si_xS_y	0908
P(1)	x	x	x	x	x	x	x	x	x	x
P(3)	x	0110 PB_6	x	x	0410	0510 (g)	x	x	0810 P_xS_y	0910 PI_3
P(5)	0011	x	x	0311	0411	0511 (g)	x	x	x	x
S(2)	x	x	0212	x	0412 S_2O_3	x	x	x	x	x
S(4)	0013	x	x	0313S_4N_4	0413 SO_2	0513 (g)	x	x	x	x
S(6)	x	0114 $B_{12}S_2$	x	x	0414 SO_3	0514 (g)	x	x	x	x
K	0015	0115 KB_6	0215 KC_8	x	0415	0515	x	x	0815 K_xS_y	0915
Ca	0016	0116 CaB_6	0216 CaC_2	0316	0416	0516	0616 $CaSi_2$	0716 Ca_3P_2	0816 CaS	0916
Sc	0017	0117 $ScB_{2;12}$	0217 Sc_xC_y	0317	0417	0517	0617	x	0817 Sc_xS_y	x
Ti(2)	x	x	x	x	0418	x	0618	x	0818 TiS	x
Ti(3)	x	x	x	0319	0419	0519	0619	0719 Ti_3P	0819 Ti_2S_3	0919
Ti(4)	0020	0120 TiB_2	0220 TiC	x	0420	0520	0620	x	0820 TiS_2	0920
V(2)	x	x	0221 V_2C	x	0421	x	0621 V_2Si	x	0821 VS	x
V(3)	x	x	0222 V_4C_3	0322	0422	0522	0622 V_3Si	x	0822 V_2S_3	0922 (h)
V(4)	x	x	0223 VC	x	0423	0523	x	0723 V_3P	x	x
V(5)	0024	0124 V_xB_y	0224 V_xC_y	x	0424	0524	0624 VSi_2	0724 VP	0824 V_2S_3	x
Cr(2)	x	x	x	x	0425	0525	x	x	0825	0925
Cr(3)	0026	x	0226 Cr_3C_2	0326	0426	0526	0626	0726 CrP	0826	x
Cr(6)	x	0127 Cr_xB_y	x	CrN	0427	x	x	x	0827 Cr_3S_4	x
Mn(2)	0028	x	x	x	0428	0528 MnF_2	0628 MnSi	0728 MnP	0828 MnS	0928
Mn(4)	x	0129 Mn_xB_y	0229 Mn_xC_y	x	0429	0529 MnF_3	0629 $MnSi_2$	0729 Mn_3P_2	0829 MnS_2	x
Mn(7)	x	x	x	x 0330 Mn_2N	0430	x	x	x	x	x
Fe(2)	0031	0131 Fe_2B	0231 Fe_3C	x	0431	0531	0631 $FeSi_x$	0731 Fe_2P	0831 FeS	0931
Fe(3)	x	0132 FeB	0232 Fe_2C_3	0332	0432	0532	x	0732 Fe_3P	0832 Fe_2S_3	x
Co(2)	0033	0133 Co_xB	x	x	0433	0533 (h)	0633 CoSi	0733 Co_2P	0833 CoS	0933
Co(3)	x	x	x	0334	0434	0534	0634 $CoSi_2$	x	0834 Co_2S_3	x
Ni	0035	0135 Ni_xB_y	0235 Ni_3C	0335	0435 NiO_x	0535	0635 Ni_xSi_y	0735 Ni_3P	0835 NiS_x	0935
Cu(1)	x	x	x	x	0436	0536	x	0736 Cu_3P	0836 Cu_2S	0936
Cu(2)	0037	0137 Cu_xB_y	x	x	0437	0537 (h)	0637	0737 Cu_3P_2	0837 CuS	x
Zn	0038	0138 ZnB_2	x	x	0438	0538	x	0738 Zn_3P_2	0838	0938
Ga	0039	x	x	x	0439	0539	x	0739	0839 Ga_xS_y	0939
Ge(2)	x	x	x	x	x	0540	x	0740 GeP	0840 GeS	0940
Ge(4)	0041	x	x	x	0441	0541	0641 Si_xGe_y	x	0841 GeS_2	0941
As(3)	x	x	x	x	0442	0542 (g)	0642	x	0842	0942
As(5)	0043	0143	x	x	0443	0543 (g)	0643	0743	0843	0943
Se(4)	x	x	x	x	0444	0544	x	x	0844 SeS	0944
Se(6)	0045	x	x	x	x	0545	x	x	0845 SeS_2	0945 Se_2I_2
Rb	0046	x	0246	x	0446 Rb_xO_y	0546	x	0746	0846 Rb_xS_y	0946
Sr	0047	0147 SrB_6	0247 SrC_2	x	0447	0547	x	0747	0847	0947
Y	0048	0148 $YB_{4;6}$	0248	0348	0448	0548 (h)	0648	0748	0848	0948
Zr	0049	0149 ZrB_2	0249	0349	0449	0549	0649	0749	0849	0949
Nb(3)	0050	0150 Nb_3B_2	0250	0350	0450 NbO	x	x	x	x	x
Nb(5)	0051	0151 NbB_2	0251 NbC	x	0451	0551	x	0751 NbP	x	x
Mo(3)	0052	x	0252 Mo_2C	0352	0452	x	x	0752 MoP	x	x
Mo(6)	x	0153 MoB_2	x	x	0453	0553 MoF_6	0653 $MoSi_2$	0753 MoP_2	0853 Mo_xS_y	0953 MoI_6
Ru(3)	x	x	x	x	0454	0554	x	x	x	x
Ru(4)	x	x	x	x	0455	0555	x	x	x	x
Ru(6)	0056	0156 Ru_xB_y	x	x	0456 RuO_4	0556 RuF_5	0656 RuSi	x	0856 RuS_2	0956 RuI
Rh	0057	0157 Rh_xB_y	x	x	0457 Rh_xO_y	0557	x	0757	0857 Rh_xS_y	x
Pd	0058	0158 Pd_xB_y	x	x	0458 Pd_xO_y	0558 Pd_xF_y	0658 Pd_2Si	x	0858 Pd_xS_y	0958
Ag	0059	x	x	x	0459 AgO	0559 Ag_xF	0659	x	0859 Ag_xS	0959
Cd	0060	x	x	x	0460	0560	x	x	0860	0960
In	0061	x	x	x	0461 In_xO_y	0561	0661	0761 InP	0861 In_xS_y	0961 InI_x
Sn(2)	x	x	x	x	0462	0562	x	0762 Sn_xP_y	0862	0962
Sn(4)	0063	x	x	x	0463	0563	0663 SnSi	x	0863	0963
Sb(3)	x	x	x	x	0464	0564	x	x	0864	0964
Sb(5)	0065	x	x	x	0465	0565 (1)	x	x	0865	0965
Te(4)	x	x	x	x	0466	0566	x	x	866 TeS_2	0966
Te(6)	0067	x	x	x	0467	0567	x	x	x	0967
Cs	0068	x	0268 CsC_8	x	0468 Cs_xO_y	0568	x	x	868 CsS_x	0968
Ba	0069	0169 BaB_6	x	x	0469	0569	x	x	869 BaS	0969(h)
La	0070	0170 $LaB_{4;6}$	0270 LaC_2	0370	0470	0570	0670	0770	870	0970
Ce(3)	x	0171 CeB_6	0271 Ce_2C_3	x	0471	0571	x	0771	871 Ce_2S_3	x

TABLE A2.2 *Continued*

Metal ion	Element	Boride	Carbide	Nitride	Oxide	Fluoride	Silicide	Phosphide	Sulphide	Iodide
Ce(4)	0072	0172 CeB_4	0272 CeC_2	0372	0472	0572 (h)	0672 $CeSi_2$	x	x	0972 (h)
Pr	0073	0173 $PrB_{4;6}$	0273 Pr_xC_y	0373	0473 Pr_xO_y	0573	0673	x	873 Pr_2S_3	x
Nd(3)	0074	0174 NdB_6	0274 Nd_2C_3	0374	0474	0574	0674 Nd_2Si_3	0774	874 Nd_2S_3	0974
Nd(4)	x	0175 NdB_4	0275 NdC_2	x	x	x	0675 Nd_3Si_4	x	x	x
Sm	0076	0176 $SmB_{4;6}$	0276 Sm_xC_y	0376	0476	0576	0676	0776	876	0976
Eu	0077	0177 $EuB_{4;6}$	0277 Eu_xC_y	0377	0477	x	x	x	877 EuS	x
Gd	0078	0178 $GdB_{4;6}$	0278 Gd_xC_y	x	0478	0578	0678 $GdSi_2$	0778	878 Gd_2S_3	x
Dy	0079	0179 $DyB_{4;6}$	0279 Dy_xC_y	0379	0479	x	0679	0779	879	x
Ho	0080	0180 $HoB_{4;6}$	0280 Ho_xC_y	0380	0480	x	x	x	x	x
Er	0081	0181 $ErB_{4;6}$	0281 Er_xC_y	0381	0481	x	0681	0781	x	x
Yb	0082	0182 $YbB_{4;6}$	0282 Yb_xC_y	0382	0482	0582	x	0782	882	x
Hf	0083	0183 HfB_2	0283 HfC	0383	0483	x	0683	0783 HfP	x	x
Ta(4)	x	x	0284 TaC	0384	0484	x	0684 Ta_2Si	x	884 TaS_2	x
Ta(5)	0085	0185 TaB_2	x	0385	0485	0585	0685 $TaSi_2$	0785 TaP	x	x
W(4)	x	x	0286 W_2C	0386 W_2N	0486 WO_2	x	0686 WSi_x	0786 WP	886 WS	0986 WI_2
W(6)	0087	0187 W_xB_y	0287 WC	0387 WN	0487 WO_3	0587 (g)	x	0787 WP_2	887 WS_2	0987 WI_4
Re	0088	0188 Re_xB_y	x	x	0488 Re_xO_y	0588 $ReF_{4;6}$	x	x	x	x
Ir	0089	0189 Ir_xB_y	x	x	0489 Ir_xO_y	0589 IrF_6	0689	x	889 IrS_x	0989 IrI_x
Pt	0090	0190 PtB	x	x	0490 Pt_xO_y	x	0690	x	890 PtS_x	0990 $PtI_{2,4}$
Au	0091	0191 Au_xB_y	x	x	0491 Au_xO_y	x	x	0791	891	0991
Tl	0092	x	x	0392 TlN_3	0492 Tl_xO_y	0592 $TiF_{1,3}$	x	x	892 Tl_xS_y	0992 Tl_xI_y
Pb(2)	x	x	x	x	0493 PbO	0593	x	x	893 PbS	0993 PbI
Pb(4)	0094	x	x	x	0494 PbO_2	x	x	x	x	0994 PbI_2
Bi	0095	x	x	x	0495	0595	x	x	895 Bi_2S_3	0995
Th	0096	0196 ThB_6	0296 ThC_2	0396	0496	0596	x	0796	896	0996
U(3)	x	x	x	x	0497 U_3O_8	x	0697 U_3Si	x	897 U_2S_3	0997
U(4)	0098	x	0298 δ-UC	x	0498 UO_2	0598	0698 U_3Si_x	0798 U_3P_4	898 US_2	0998
U(6)	x	0199 U_xB_y	0299 UC_2	0399	0499 UO_3	0599 (g)	x	x	x	0999
Other	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900

A2.4 Four-Digit Codes for Other Compounds

A2.4.1 For specific chemical compounds that are not available from Table A2.2, a four-digit code is specified. The four digits in the chemistry code will identify the item as belonging to one of the specific listed types. The listing is arranged in accordance to the following heirarchy:

1000 to 1999	Binary stoichiometric compounds and compositions not directly available from the matrix
2000 to 2999	Ternary stoichiometric compounds
3000 to 3999	Other stoichiometric compounds
4000 to 4999	Nonstoichiometric compounds
5000 to 9999	Designated compositional bands defined for generic material types

NOTE A2.1—This four-digit code system provides sufficient space for the materials of more complex composition that are in current usage and will allow additions of items which may warrant inclusion in the future.

A2.4.2 Codes 5000 to 9999 are for specific material types or compositions, and are included in order to provide simple identifiable codes for complex materials in common usage where full chemical identification is neither practical nor desirable. In practice, this situation leads to the possibility of identifying a product either by a combination of simple compound codes or by a single four-digit code representing a material group. It is not possible to avoid this situation without losing a great deal of flexibility in use, but the numbering system remains unique. In any computer-based method of handling the codes, links between these possibilities must be identified in order to ensure parallel identification of the synonyms.

A2.4.3 The following general rules should be followed:

A2.4.3.1 For precursors and powders of high purity or where purity may need to be defined, four-digit codes shall be used from the range 0001 to 4999.

A2.4.3.2 For precursors, powders, ceramics, glasses, or glass-ceramics of general compositional type where purity or detailed composition is not to be defined, a four-digit code from the range 5000 to 9999 shall normally be used.

A2.4.3.3 For ceramics, glasses, or glass-ceramics where detailed composition in component form is to be identified, four-digit codes from the range 0001 to 4999 shall be used in combination optionally with codes for amounts present and relational form of secondary components.

A2.5 Classification Codes for Two-Component Stoichiometric Species, Codes 1000 to 1999

A2.5.1 The following grouping is employed:

1000 to 1099	Aluminides
1100 to 1199	Antimonides
1200 to 1299	Arsenides
1300 to 1399	Bromides
1400 to 1499	Chlorides
1500 to 1599	Hydrides
1600 to 1699	Selenides
1700 to 1799	Tellurides
1800 to 1899	Binary components with other radicals

A2.5.2 See Table A2.3 for individual classified components.

A2.6 Classification of Three-Component Stoichiometric Compounds, Codes 2000 to 2999

A2.6.1 This classification is divided into the following alphabetical heirarchy:

TABLE A2.3 Two-Component Stoichiometric Species—Individual Classified Components

1000	Nickel aluminide
1099	Other aluminides
1100	Indium antimonide
1101	Lead antimonide
1102	Nickel antimonide
1103	Potassium antimonide
1104	Sodium antimonide
1199	Other antimonides
1200	Cadmium arsenide
1201	Copper arsenide
1202	Indium arsenide
1203	Nickel arsenide
1299	Other arsenides
1300	Beryllium bromide
1301	Boron bromide
1302	Cadmiunm bromide
1303	Indium bromide
1304	Lithium bromide
1305	Nickel bromide
1306	Silicon bromide
1399	Other bromides
1400	Boron trichloride
1401	Calcium chloride
1402	Cerium chloride
1403	Chromium chloride
1404	Indium chloride
1405	Lithium chloride
1406	Magnesium chloride
1407	Nickel chloride
1408	Potassium chloride
1409	Silicon chloride
1499	Other chlorides
1500	Boron hydride
1501	Lithium hydride
1502	Silicon hydride
1503	Titanium hydride
1599	Other hydrides
1600	Copper selenide
1601	Indium selenide
1602	Zinc selenide
1699	Other selenides
1700	Indium telluride
1701	Lead telluride
1799	Other tellurides
1999	Other binary stoichiometric compounds

2000 to 2049	Aluminates
2050 to 2099	Borates
2100 to 2109	Cerates
2110 to 2119	Chromites
2120 to 2149	Cuprates
2150 to 2199	Ferrites
2200 to 2249	Ferrates
2249 to 2299	Germanates
2300 to 2349	Manganates
2349 to 2399	Niobates
2400 to 2449	Phosphates
2450 to 2549	Silicates
2550 to 2599	Stannates
2600 to 2649	Sulphates
2650 to 2749	Titanates
2750 to 2799	Tungstates
2800 to 2849	Vanadates
2850 to 2899	Zirconates
2900 to 2999	Other three-component species

A2.6.2 See Table A2.4 for individual classified components.

A2.7 Classification Codes for Other Stoichiometric Compounds, Codes 3000 to 3999

A2.7.1 There is a wide variety of materials falling into this category, so only a broad heirarchy can be defined:

3000 to 3399	Oxide-based compounds
3400 to 3699	Nonoxide-based compounds
3700 to 3999	Mixed oxide/nonoxide-based compounds

A2.7.2 See Table A2.5 for individual classified compounds.

A2.8 Classification Codes for Nonstoichiometric Compounds, Codes 4000 to 4999

A2.8.1 The four-digit numeric codes in the range from 4000 to 4999 defining the chemical types are given in the following list:

4999 Other nonstoichiometric compounds

A2.9 Classification and Codes for Defined Product Types

A2.9.1 The four-digit numeric codes in the range from 5000 to 9999 defining the chemical types are obtained from Table A2.6 in alphabetical order of the first metallic species by which the product is normally known from its chemical formula.

NOTE A2.2—There may be occasions where there is no preferred name. For example, yttrium aluminate and aluminium yttrate are equal names for yttrium aluminium garnet (YAG). In such cases it is recommended to search the coding list for both names. If neither is found, use the *other* classification for the principal metal species appearing highest in the alphabetical list, in this case under aluminium.

NOTE A2.3—To aid identification of materials described by mineral or other nonchemical names, porcelains may be found under aluminosilicates; micra-based products will be found under aluminosilicates; cordierites will be found under magnesium aluminosilicates; steatites and forsterites will be found under magnesium silicates; apatite-based materials may be found under phosphates.

TABLE A2.4 Three-Component Stoichiometric Compounds—Individual Classified Compounds

2000	Barium aluminate
2001	Beryllium aluminate
2002	Calcium aluminate
2003	Lithium aluminate
2004	Magnesium aluminate
2005	Potassium aluminate
2006	Sodium aluminate
2007	Zinc aluminate
2049	Other aluminates
2050	Aluminium borate
2051	Lithium borate
2052	Potassium borate
2053	Sodium borate
2054	Zinc borate
2099	Other borates
2100	Strontium cerate
2109	Other cerates
2110	Lanthanum chromite
2119	Other chromates or chromites
2120	Aluminium cuprate
2121	Barium cuprate
2122	Lanthanum cuprate
2123	Neodymium cuprate
2124	Praesodymium cuprate
2149	Other cuprates
2150	Calcium ferrite
2151	Cobalt ferrite
2152	Lead ferrite
2153	Magnesium ferrite
2154	Manganese ferrite
2155	Nickel ferrite
2156	Sodium ferrite
2157	Zinc ferrite
2199	Other ferrites
2200	Copper ferrate
2201	Nickel ferrate
2202	Zinc ferrate

TABLE A2.4 *Continued*

2249	Other ferrates
2250	Lithium germanate
2251	Potassium germanate
2252	Sodium germanate
2299	Other germanates
2300	Barium manganate
2301	Nickel manganate
2349	Other manganates
2350	Lead niobate
2351	Lithium niobate
2399	Other niobates
2400	Aluminium phosphate
2401	Cadmium phosphate
2402	Calcium phosphate
2403	Lead phosphate
2404	Lithium phosphate
2405	Magnesium phosphate
2406	Manganese phosphate
2407	Potassium phosphate
2408	Sodium phosphate
2409	Zinc phosphate
2410	Zirconyl phosphate
2449	Other phosphates
2450	Aluminium silicate
2451	Barium silicate
2452	Beryllium silicate (beryl)
2453	Cadmium silicate
2454	Calcium silicate
2455	Cobalt silicate
2456	Iron silicate
2457	Lead silicate
2458	Lithium silicate
2459	Magnesium silicate ($MgSiO_3$, enstatite)
2460	Magnesium silicate ($2MgO.SiO_2$, forsterite)
2461	Potassium silicate
2462	Sodium silicate
2463	Zinc silicate (willemite)
2464	Zirconium silicate (zircon)
2549	Other silicates
2550	Indium stannate
2599	Other stannates
2600	Barium sulphate
2601	Calcium sulphate
2649	Other sulphates
2650	Aluminium titanate
2651	Barium titanate
2652	Calcium titanate
2653	Iron titanate
2654	Lead titanate
2655	Lithium titanate
2656	Magnesium titanate
2657	Manganese titanate
2658	Potassium titanate
2659	Sodium titanate
2660	Strontium titanate
2749	Other titanates
2750	Calcium tungstate
2751	Cerium tungstate
2752	Iron tungstate
2753	Lead tungstate
2754	Lithium tungstate
2755	Potassium tungstate
2756	Sodium tungstate
2799	Other tungstates
2800	Iron vanadate
2849	Other vanadates
2850	Calcium zirconate
2851	Lead zirconate
2852	Lithium zirconate
2853	Magnesium zirconate
2854	Titanium zirconate
2899	Other zirconates
2999	Other three-component stoichiometric compounds

TABLE A2.5 Other Stoichiometric Compounds—Individual Classified Compounds

3000	Aluminium zirconium silicate
3001	Antimony sulphur iodide
3002	Barium aluminium silicate
3003	Barium magnesium aluminium silicate (barium osumilite)
3004	Bismuth strontium calcium copper oxide
3006	Calcium aluminium silicate
3007	Calcium magnesium silicate
3008	Calcium strontium barium zirconate
3011	Lead fluorosilicate
3012	Lead lanthanum zirconate titanate
3013	Lead magnesium tungstate
3014	Lead nickel tungstate
3016	Lead zirconate titanate
3017	Lithium aluminium silicate
3019	Lithium cadmium silicate
3020	Lithium zinc silicate
3022	Magnesium aluminium silicate (cordierite)
3023	Manganese copper ferrite
3024	Manganese magnesium ferrite
3025	Manganese magnesium zinc ferrite
3026	Manganese zinc ferrite
3027	Nickel zinc ferrite
3028	Potassium aluminium silicate (feldspar)
3030	Sodium aluminium silicate (feldspar)
3032	Sodium zirconium aluminate
3033	Ytterbium barium titanate
3034	Yttrium aluminium silicate
3035	Yttrium barium copper oxide
3036	Yttrium iron silicate
3399	Other complex oxide compounds
3700	Aluminium oxynitride (Alon)
3701	Silicon oxynitride
3702	Silicon aluminium oxynitride
3749	Other oxynitrides
3801	Silicon oxycarbide
3849	Other oxycarbides
3901	Titanium carbonitride
3949	Other carbonitrides
3999	Other nonoxide-based compounds

TABLE A2.6 Codes Defining Chemical Types

5000–5100	Materials based on α-alumina
5001	Al_2O_3 materials—Ultra-high puriity (> =99.99 %)
5005	Al_2O_3 materials—Extreme high purity (99.8–≤99.99 %)
5010	Al_2O_3 materials—Very high purity (99.5–99.8 %)
5020	Al_2O_3 materials—High purity (99–99.5 %, IEC 672 Class C 799)
5030	Al_2O_3 materials—technical (96.5–99 % alumina, IEC Class C 795)
5040	Al_2O_3 materials—technical (94–96.5 % alumina, IEC Classes C 786, C 795)
	5041 with CaO/SiO_2 additives
	5042 with $MgO/CaO/SiO_2$ additive
	5043 with MnO/TiO_2 additive
	5049 with other additives
5050	Al_2O_3 materials—technical (>90–≤94 % alumina, IEC 672 Class C 786)
	5051 with CaO/SiO_2 additives
	5052 with $MgO/CaO/SiO_2$ additive
	5053 with MnO/TiO_2 additive
	5059 with other additives
5060	Al_2O_3 materials—technical (>80–≤90 % alumina, IEC Classes C 780, C 786)
	5061 with CaO/SiO_2 additives
	5062 with $MgO/CaO/SiO_2$ additive
	5063 with MnO/TiO_2 additive
	5069 with other additive
5070	Al_2O_3 materials—≤80 % alumina
5080	Al_2O_3/ZrO_2 materials
5100–5149	Other Al_2O_3-based materials
5100	Gamma alumina
5101	Delta alumina
5110	Tabular alumina
5120	Sapphire

TABLE A2.6 *Continued*

5121	Ruby
5130	sodium β-alumina
5149	Other types of alumina
5150–5199	Alumina matrix composites
5150	containing SiC long fiber
5159	containing other fiber
5160	containing SiC whiskers
5169	containing other whiskers
5170	containing SiC platelets
5179	containing other platelets
5180	containing SiC particulates
5181	containing TiC particulates
5182	containing ZrO_2 particulates
5189	containing other particulates
5190	containing SiC whiskers and ZrO_2 particulates
5199	Other alumina matrix composites
5200–5209	Aluminium nitrides
5200	Electronic grade (metallic impurity level < 200 ppm)
5205	Technical grade (metallic impurity level > 200 ppm)
5209	Other aluminium nitrides
5210–5219	Aluminium oxynitrides
5200	Optical-grade aluminium oxynitride
5205	Aluminium nitride polytypoids (for example, 15R)
5219	Other aluminium oxynitrides
5220–5349	Aluminosilicate based materials
5220	Fused mullite
5221	Calcined mullite
5222	Molochite-based
5223	Sillimanite-based
5224	Kyanite-based
5225	Andalusite-based
5226	Pyrophillite-based
5230	High-purity sintered mullite
5231	Mullite/zirconia ceramics
5232	Mullite ceramics (IEC 672 Class C 600)
5239	Other mullite based materials
5310	Siliceous alkali porcelain materials (IEC 672 Class C 110)
5311	Siliceous alkali porcelain materials, pressed (IEC 672 Class C 111)
5320	Siliceous alkali porcelain materials, high strength (IEC 672 Class C 120)
5330	Siliceous alkali porcelain materials, high strength (IEC 672 Class C 130)
5340	Natural mica based materials
5341	Fluorine substituted mica-based materials
5344	Other mica-based materials
5349	Other aluminosilicate-based materials
5350–5355	Aluminium titanate-based materials
5350	Stoichiometric aluminium titanate
5351	Aluminium titanate with stabilisers
5355	Other aluminium titanate-based materials
5360	Antimony-based materials
5380–5449	Barium-based materials
5380	Barium carbonate-based materials
5390	Barium silicate-based materials
5395	Barium aluminosilicate-based materials (celsian)
5400	Barium titanate-based materials
5440	Barium fluoride-based materials
5449	Other barium-based materials
5450–5489	Beryllium-based materials
5450	Beryllia, high-purity, high thermal conductivity (>99.5 % BeO, IEC 672 Class C 810)
5451	Beryllia, medium purity, medium thermal conductivity (95–99.5 % BeO, IEC 672 Class C 810)
5460	Beryllia/SiC composites
5469	Other beryllia-based materials
5470	Beryllium boride-based materials
5489	Other beryllium-based materials
5490–5499	Bismuth-based materials
5490	Bismuth oxide-based materials
5495	Bismuth calcium strontium copper oxide materials
5499	Other bismuth-based materials
5500–5529	Boron carbide-based materials
5500	Dense pure near-stoichiometric materials
5505	Non-stoichiometric materials
5510	Dense, containing boron additive

TABLE A2.6 *Continued*

5511	Dense, containing carbon additive
5520	Boron carbide/titanium diboride composites
5529	Other boron carbides
5530–5549	Boron nitride-based materials
5530	Hot-pressed hexagonal boron nitride
5535	CVD hexagonal boron nitride
5539	Cubic boron nitride materials
5540	Boron nitride/titanium diboride composites
5549	Other boron nitride composites
5550–5579	Calcium-based materials
5551	Calcium oxide-based materials
5552	Calcium silicate-based materials
5555	Calcium aluminosilicate-based materials
5560	Calcium magnesium silicate-based materials
5565	Calcium zirconium silicate-based materials
5569	Other calcium oxide-based materials
5570	Calcium fluoride-based materials
5579	Other calcium-based materials
5580–5599	Carbon-based materials
5580	Diamond single crystals
5581	Diamond-based composites
5582	Diamond-like films
5585	CVD graphite
5590	Vitreous carbon
5595	Fullerenes
5599	Other carbon-based materials
5600–5609	Cerium-based materials
5600	Cerium oxide-based materials
5605	Cerium sulphide-based materials
5609	Other cerium-based materials
5610–5619	Chromium-based materials
5610	Chromia-based materials
5619	Other chromium-based materials
5620	Cobalt-based materials
5630–5639	Copper-based materials
5630	Copper oxide-based materials
5639	Other copper-based materials
5640	Dysprosium-based materials
5650	Erbium-based materials
5660	Europium-based materials
5670–5679	Gadolinium-based materials
5670	Gadolinium iron garnet materials
5679	Other gadolium-based materials
5680	Gallium oxide-based materials
5690	Germanium oxide-based materials
5700–5709	Hafnium-based materials
5700	Hafnium oxide-based materials
5705	Hafnium carbide-based materials
5709	Other hafnium-based materials
5710–5749	Iron-based materials
5710	Iron oxide-based materials
5720	Iron silicate-based materials
5730	Iron chromate-based materials
5740	Iron sulphide-based materials
5749	Other iron-based materials
5750	Lanthanum-based materials
5760–5829	Lead-based materials
5760	Lead oxide-based materials
5770	Lead monosilicate-based materials
5780	Lead bisilicate materials
5790	Lead titanate-based materials
5800	Lead zirconate-based materials
5810	Lead niobate-based materials
5820	Lead lithium niobate materials
5829	Other lead-based materials
5830–5899	Lithium-based materials
5830	Petalite-based materials
5835	Spodumene-based materials
5840	Eucryptite-based materials
5859	Other lithium aluminium silicate-based materials
5860	Lithium aluminate-based materials
5870	Lithium titanate-based materials
5880	Lithium zirconate-based materials
5899	Other lithium-based materials
5900–6099	Magnesium-based materials
5900	Fused magnesia

TABLE A2.6 *Continued*

5901	Sintered magnesia, high purity, dense
5902	Sintered magnesia, porous, crushable (IEC 672 Class C 820)
5903	Silicate bonded dense magnesia
5910	Doloma materials (MgO/CaO)
5919	Other magnesium oxide-based materials
5920	Magnesium aluminate-based materials
5920	Transparent spinel ceramics
5921	Technical grade spinel ceramics
5930	Fused spinel
5935	Calcined spinel
5949	Other magnesium aluminate-based materials
5950	Magnesium aluminium silicates (cordierite and cordierite composites) > 95 % cordierite
5951	70–95 % cordierite
5952	< 70 % cordierite (secondary phases unspecified)
5960	cordierite-based glass-ceramics
5970	cordierite/mullite composites
5999	other cordierite-based materials
6000–6049	Magnesium silicate-based materials
6000	Steatite-based materials, IEC Class C 210
6001	Steatite-based materials, IEC Class C 220
6002	Steatite-based materials, IEC Class C 221
6003	Steatite-based materials, porous, IEC Class C 250
6010	Forsterite-based materials, IEC Class C 230
6011	Forsterite-based materials, porous, IEC Class C 240
6080	Magnesium fluoride-based materials
6099	Other magnesium-based materials
6100	Neodymium-based materials
6120–6139	Nickel-based materials
6120	Nickel oxide-based materials
6130	Nickel ferrite-based materials
6139	Other nickel-based materials
6140	Niobium-based materials
6150–6159	Phosphate and apatite-based materials
6150	Hydoxyapatite
6151	Fluorapatite
6159	Other phosphate-based materials
6160–6169	Potassium-based materials
6160	Potassium silicate-based materials
6161	Potassium silicon fluoride-based materials
6169	Other potassium-based materials
6170	Samarium-based materials
6180	Scandium-based materials
6200–6369	Silicon-based materials
6200	Fused vitreous silica
6201	Fused quartz
6210	Sintered fused silica
6220	Quartz crystal
6239	Other silica-based materials
6250	Alpha silicon carbide powder, whiskers and platelets
6251	Beta silicon carbide powder, whiskers and platelets
6260	Sintered alpha silicon carbide dense ceramics
6261	Sintered alpha silicon carbide porous ceramics
6262	Sintered alpha silicon carbide/titanium nitride composite materials
6270	Sintered beta silicon carbide ceramics
6280	Reaction bonded silicon carbide (free silicon)
6285	Siliconised silicon carbide (infiltrated after sintering)
6290	CVD silicon carbide
6300	Silicon nitride bonded silicon carbide
6309	Other silicon carbide-based materials
6310	Si-C-O-N fibers
6311	Si-Ti-C-O-N fibers
6319	Other silicon carbide-based fibers
6320	Silicon carbide fiber reinforced silicon carbide
6329	Other silicon carbide fiber reinforced materials
6330	Alpha silicon nitride
6331	Beta silicon nitride
6335	Porous (reaction bonded) silicon nitride
6340	Dense silicon nitride, no additives
6345	Dense silicon nitride with additives
6350	Dense β'-sialon-based materials
6351	Dense β'-sialon/titanium nitride-based materials
6352	Dense α'-sialon-based materials
6355	Silicon oxynitride-based materials

TABLE A2.6 *Continued*

6358	CVD silicon nitride materials
6359	Other silicon nitride materials
6369	Other silicon-based materials
6370–6399	Sodium-based materials
6370	Sodium aluminate-based materials
6380	Sodium orthosilicate-based materials
6381	Sodium metasilicate-based materials
6390	Sodium silicon fluoride materials
6399	Other sodium-based materials
6400–6419	Strontium-based materials
6400	Strontium cerate-based materials
6410	Strontium titanate-based materials
6419	Other strontium-based materials
6420–6429	Thorium-based materials
6420	Thorium oxide-based materials
6429	Other thorium-based materials
6430	Tin oxide-based materials
6440–6489	Titanium-based materials
6440	Titania materials (fully oxidised)
6441	Reduced titania materials
6449	Other titania-based materials
6450	Titanium carbide-based materials
6460	Titanium nitride-based materials
6489	Other titanium-based materials
6490–6509	Tungsten-based materials
6490	Tungsten oxide-based materials
6500	Tungsten carbide-based materials
6509	Other tungsten-based materials
6510–6519	Uranium-based materials
6510	Uranium oxide-based materials
6511	Uranium carbide-based materials
6519	Other uranium-based materials
6520	Vanadium-based materials
6530–6579	Yttrium-based materials
6530	Yttrium oxide-based materials
6540	Yttrium aluminium garnet-based materials
6550	Yttrium iron garnet-based materials
6570	Yttrium barium copper oxide-based materials
6579	Other yttrium-based materials
6580–6609	Zinc-based materials
6580	Bismuth doped zinc oxide materials
6581	Rare earth doped zinc oxide materials
6590	Zinc silicate (willemite)-based materials
6600	Zinc zirconium silicate-based materials
6609	Other zinc-based materials
6620–6799	Zirconium-based materials
6620	Monoclinic zirconia powder
6621	Tetragonal zirconia powder
6630	Zirconia fully stabilized with MgO
6631	Zirconia fully stabilized with CaO (IEC 672 Class C 830)
6632	Zirconia fully stabilized with Y_2O_3
6635	Zirconia fully stabilized with mixed Mgo/CaO/Y_2O_3 stabiliser
6639	Other fully stabilized materials
6640	Partially stabilized with MgO (Mg-partially stabilized zirconia (PSZ) type)
6641	Partially stabilized with CaO (Ca-PSZ type)
6645	Partially stabilized with Y_2O_3(Y—tetragonal zirconia polycrystal (TZP) type)
6650	Partially stabilized with CeO_2(Ce-TZP)
6659	Other partially stabilized materials
6699	Other zirconium oxide based materials
6700	Zirconium silicate based materials (zircon)
6720	Zirconium spinel based materials
6740	Zirconium carbide based materials
6750	Zirconium diboride based materials
6799	Other zirconium based materials
8000–8999	Glass materials (see under silica materials above for vitreous silica)
8110	Soda-lime-silica (annealed, IEC 672 Class G 110)
8120	Soda-lime-silica (thermally toughened, IEC 672 Class G 120)
8200	Borosilicate, chemically resistant (IEC 672 Class G 200)
8310	Borosilicate, electrically resistant, low loss (IEC 672 Class G 310)
8400	Alumina-lime-silica (IEC 672 Class G 400)

TABLE A2.6 *Continued*

8500	Lead oxide alkai silica (IEC 672 Class G 500)
8600	Baria alkali silica (IEC Class G 600)
8700	Lead zinc borate
8800	Alumino-borate based glasses
8999	Other glasses
9000–9999	Glass-ceramic materials
9000	Lithium aluminosilicate type
9010	Magnesium aluminosilicate type
9020	Lithium zinc silicate type
9999	Other glass-ceramics

A3. PROCESSING CLASSIFICATION FIELD

A3.1 This field is uniquely identified by the initial letter *P*. This is followed by a two-digit code. The classification list for processing steps involved in the production of advanced (technical) ceramics is grouped in accordance with the heirarchy given in Table A3.1.

A3.2 An alphabetical listing of process codes is given in Table A3.2.

A3.3 A flowchart for construction of the code for processing, which is to be used in conjunction with this annex, is shown in Fig. A3.1.

TABLE A3.1 Processing Steps for Production of Advanced Ceramics

01 to 04	Preparation/manufacture of precursors
	01 Preparation of Precursors & Powders
	02 Manufacture of gaseous pre-ceramic precursors
	03 Manufacture of sol/gel pre-ceramic precursors
	04 Manufacture of other pre-ceramic precursors
05 to 10	Manufacture of powders
	05 Manufacture of powders by calcination/milling
	06 Manufacture of powders by fusion/crushing/milling
	07 Manufacture of powders by chemical precipitation
	08 Manufacture of powders by gas-phase reaction

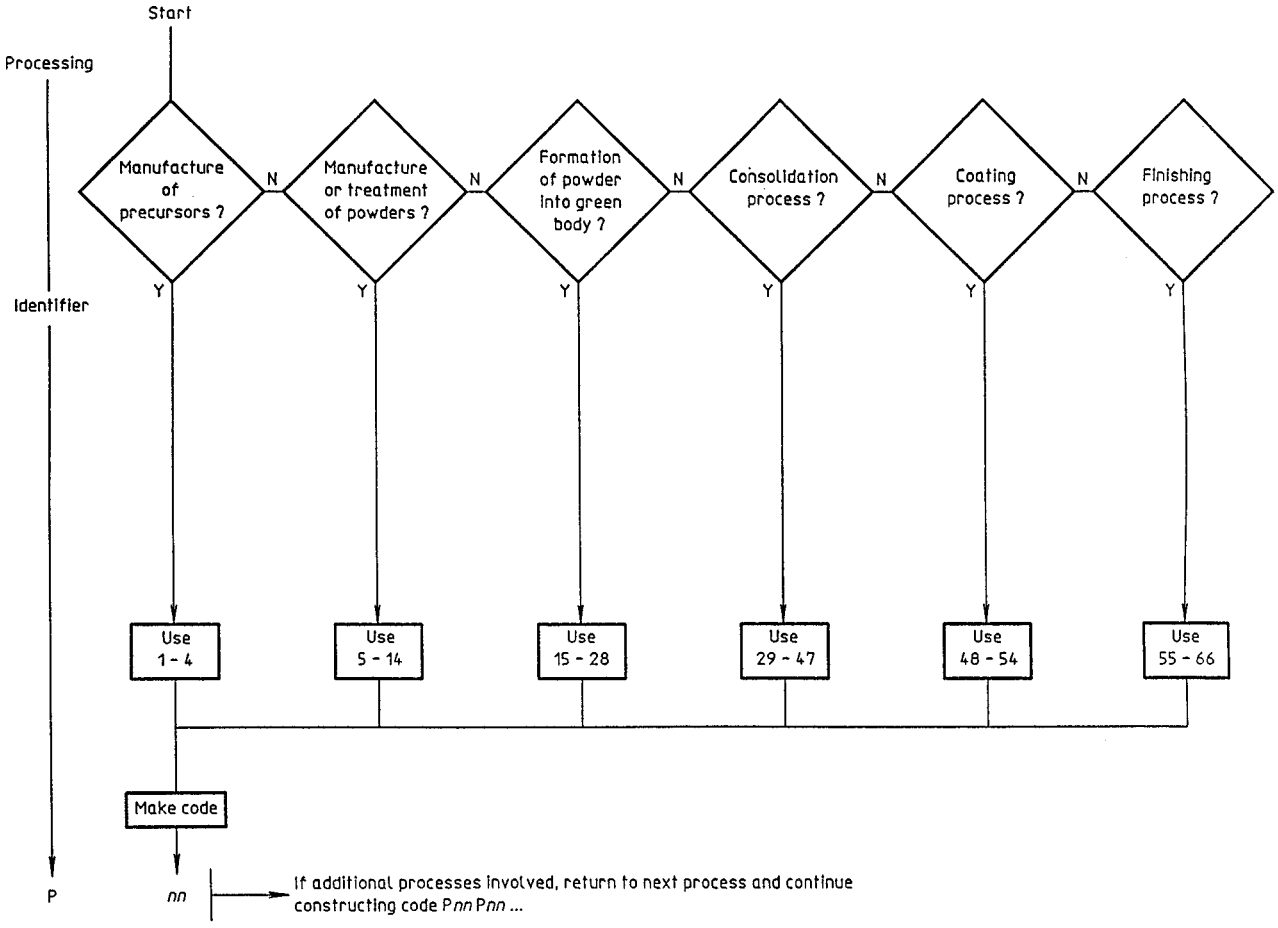

FIG. A3.1 Flowchart for Construction of the Code for Processing

TABLE A3.1 *Continued*

	09 Manufacture of powders by flame pyrolysis
	10 Manufacture of powders by sol/gel technique
11 to 15	Processing of powders
	11 Powder in the as-manufactured state
	12 Granulation by spray drying
	13 Freeze drying of powder
	14 Powder formed by filter pressing/granulation
	15 Milling of powder
16 to 28	Compaction of powders
	16 Uniaxial pressing of powder
	17 Green machining of powder compact
	18 Isostatic pressing of powder
	19 Unassisted slip casting
	20 Pressure slip casting
	21 Tape casting
	22 Injection moulding
	23 Compression molding
	24 Roll compaction
	25 Extrusion by ram extruder
	26 Auger extruded
	27 Electrophoretically deposited
	28 Other green forming process
29 to 47	Consolidation of powders
	29 Consolidation by pressureless (atmospheric pressure) sintering
	30 Consolidation by air atmosphere sintering
	31 Consolidation by controlled (non-ambient) atmosphere sintering
	32 Vacuum sintering
	33 Gas pressure sintering
	34 Sinter—HIP
	35 Encapsulated HIPPing
	36 Post-sintering HIPPing
	37 Uniaxial hot pressing
	38 Self-sustained high-temperature synthesis
	39 Liquid-phase reaction bonding
	40 Gas-phase reaction bonding
	41 Chemical vapor deposition
	42 Chemical vapor infiltration (bonding)
	43 Plasma/flame spraying
	44 Controlled interface reaction
	45 Chemically bonding
	46 Sol-gel consolidation techniques
	47 Other consolidation processes
48 to 54	Production of coatings
	48 CVD coating process
	49 PVD coating process
	50 Ion plating coating process
	51 Ion implantation
	52 Sol-gel coating processes
	53 Sputtering
	54 Other coating processes
	55 Melt forming
	56 Vapor forming
	57 Other consolidation processes
58 to 66	Post-consolidation processes
	58 As-manufactured, that is, no post-consolidation process
	59 Rumbled/vibro milled surface
	60 Abraded surface
	61 Ground surface (fixed grit)
	62 Lapped surface (free grit)
	63 Polished surface
	64 Machined and refired
	65 Metallized
	66 Brazed

TABLE A3.2 Alphabetical Listing of Process Codes

Abraded surface	60
As-manufactured (that is, no post-consolidation process)	58
Auger extruded	26
Brazed	66
Chemically bonding	45
Chemical vapor deposition	41
Chemical vapor infiltration (bonding)	42
Compression moulding	23
Consolidation by air atmosphere sintering	30
Consolidation by controlled (non-ambient) atmosphere sintering	31
Consolidation by pressureless (atmospheric pressure) sintering	29
Controlled interface reaction	44
CVD coating process	48
Electrophoretically deposited	27
Encapsulated HIPPing	35
Extrusion by ram extruder	25
Freeze drying of powder	13
Gas-phase reaction bonding	40
Gas pressure sintering	33
Granulation by spray drying	12
Green machining of powder compact	17
Ground surface (fixed grit)	61
Injection moulding	22
Ion plating coating process	50
Ion implantation	51
Isostatic pressing of powder	18
Lapped surface (free grit)	62
Liquid-phase reaction bonding	39
Machined and refired	64
Manufacture of gaseous pre-ceramic precursors	2
Manufacture of other pre-ceramic precursors	4
Manufacture of powders by calcination/milling	5
Manufacture of powders by chemical precipitation	7
Manufacture of powders by flame pyrolysis	9
Manufacture of powders by fusion/crushing/milling	6
Manufacture of powders by gas-phase reaction	8
Manufacture of powders by sol/gel technique	10
Manufacture of sol/gel pre-ceramic precursors	3
Melt forming	55
Metallized	65
Milling of powder	15
Other coating processes	54
Other consolidation processes	47
Other green forming process	28
Plasma/flame spraying	43
Polished surface	63
Post-sintering HIPPing	36
Powder formed by filter pressing/granulation	14
Powder in the as-manufactured state	11
Pressure slip casting	20
PVD coating process	49
Roll compaction	24
Rumbled/vibro milled surface	59
Self-sustained high-temperature synthesis	38
Sinter—HIP	34
Sol-gel coating processes	52
Sol-gel consolidation techniques	46
Sputtering	53
Tape casting	21
Unassisted slip casting	19
Uniaxial hot pressing	37
Uniaxial pressing of powder	16
Vacuum sintering	32
Vapor forming	56

A4. PROPERTY DATA CLASSIFICATION FIELDS

A4.1 Introduction

A4.1.1 This field is uniquely identified by the initial letter *D*.

A4.1.2 The information contained in this field of classification relates to the identification of the important properties together with an indication that either that property is a target in the formulation of the material, in which case the presence of the code is sufficient to indicate this or a numerical range in which the property falls for classification purposes.

A4.1.3 Since a number of properties may need to be identified, the field identifier *D* also acts as a separator in a multielement data coding string.

A4.1.4 The property measurement used for the classification system, shall, wherever possible, be measured and reported in accordance with approved national or international standards.

A4.1.5 The property data classification codes are given in Table A4.1.

A4.1.6 A flowchart for construction of the code from property data, which is to be used in conjunction with this annex, is shown in Fig. A4.1.

A4.2 Coding Structure

A4.2.1 The coding for this descriptor should contain the following essential items of information:

A4.2.1.1 Descriptor identification (letter *D*),

A4.2.1.2 Property Type (digit),

A4.2.1.3 Property (two digits), and

A4.2.1.4 Numerical range of property (digit).

A4.2.2 Optional information (Table A4.2) that may be included if desired or necessary to aid classification are qualifications such as:

A4.2.2.1 Temperature at which or up to which the property range refers, and

A4.2.2.2 Frequency at which or up to which the property range refers (electrical properties only).

A4.2.3 The format for the property data classification code is as follows:

Djk1k2lmn

where:

- j = single number indicating the property group (physical, thermal, electrical etc.),
- k_1k_2 = two numbers identifying the specific property within that group,
- l = single number indicating the range of that property,
- m = single number indicating qualification of the property range by temperature (when necessary), and
- n = single number indicating qualification of the property range by frequency (when necessary, but must follow the temperature code element).

A4.2.4 In many cases either or both of the latter two numbers may be redundant and could be omitted to yield a simplified code such as:

$$Djk_1k_2l \quad or \quad Djk_1k_2lm$$

A4.3 Data Classification Table

A4.3.1 Table A4.1 gives the data coding table. The numerical coding associated with the property data descriptor field are obtained from the individual parts of the code as follows:

j	(Column 2 in Table A4.1)—property type
k_1k_2	(Column 3 in Table A4.1)—property
l	(Columns 4 to 12 in Table A4.1)—range
m	(Column 2 in Table A4.2)—temperature qualifier
n	(Column 3 in Table A4.2)—frequency qualifier

A4.3.2 The code is constructed from at least elements j and k_1k_2. If a numerical value is ascribed to the property measured in accordance with a prescribed test method (Column 13 of Table A4.1 gives examples of test method designation) Element 1 may be added. If Element 1 is added, the prescribed test method designation should follow in the string using the standards organizations issue code; Table A4.1 lists some examples of test method designation codes. Unless the Temperature Code m is added, the property shall be that at room temperature. The temperature code shall always be used for thermal expansion data. If frequency is to be added, for electrical properties, it must be preceded by the temperature code to avoid ambiguity.

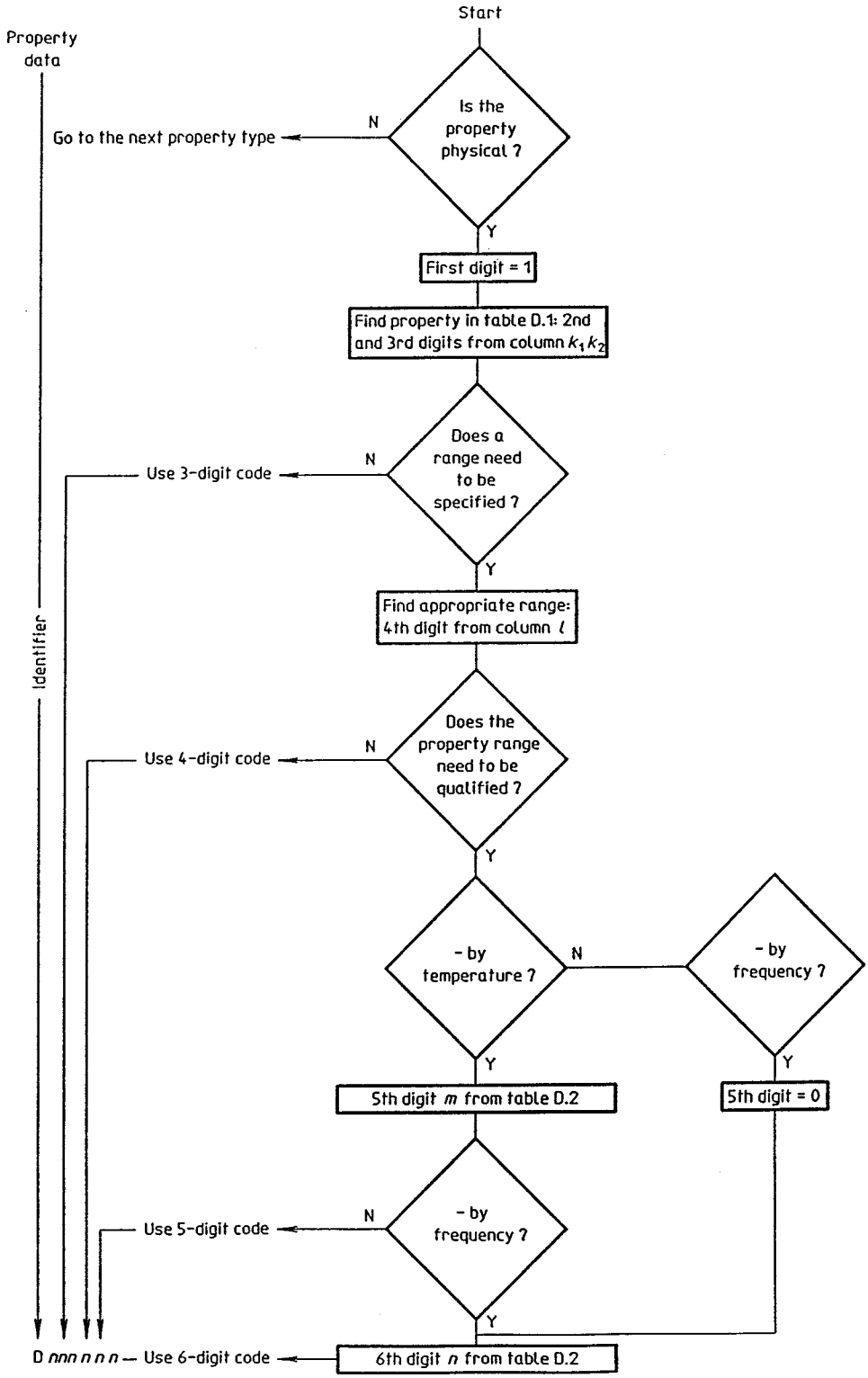

FIG. A4.1 Flowchart for Construction of the Code from Property Data

TABLE A4.1 Property Data Classification Codes

Property and Type	j	k_1k_2	1	2	3	4	5	6	7	8	9	Test Method A=monolithic B=composites C=coatings D=powders
Physical Properties	1		Product displays physical properties critical to its function									
Bulk density, % theoretical	1	01	≤20 %	>20–40 %	>40–60 %	>60–80 %	>80–95 %	>95–99 %	>99 %			
Open porosity, %	1	02	≤1	>1–5	>5–10	>10–30	>30–50	>50–80	>80			
Grain size (μm), mean linear intercept method	1	03	≤1	>1–3	>3–8	>8–25	>25–100	>100				
Powder mean particle size, μm	1	04	≤0.01	>0.01–0.05	>0.05–1.0	>1.0–3.0	>3.0–10	>10–30	>30.0–100	>100		
Powder surface area, $m^2\ g^{-1}$	1	05	≤1	>1–2	>2–5	>5–10	>10–20	>20–50	>50–100	>100		
Powder tap density, Mg/m^{-3}	1	06	≤0.1	>0.1–0.2	>0.2–0.5	>0.5–1.0	>1.0–1.5	>1.5–2.0	>2.0–3.0	>3.0–5.0	>5.0	
Powder flow cone angle	1	07	Important characteristic of product									
Fiber/whisker diameter, mean μm	1	08	≤0.1	>0.1–0.5	>0.5–1.0	>1.0–3.0	>3.0–8.0	>8.0–15.0	>15.0–50.0	>50		
Chopped fiber or whisker length, mean	1	09	Important characteristic of product									
Fiber/whisker aspect ratio	1	10	Important characteristic of product									
Fiber/whisker/ platelet volume fraction	1	11	Important characteristic of product									
Coating thickness, μm	1	12	≤0.1	>0.1–1.0	>1.0–10.0	>10.0–100	>100–1000	>1000–10 000	>10 000			
Surface roughness, Ra, μm	1	13	≤0.01	>0.01–0.02	>0.02–0.05	>0.05–0.10	>0.10–0.20	>0.20–0.50	>0.50–1.0	>1.0–2.0	>2	
Mechanical Properties	2		Product displays mechanical properties critical to its function									
Flexural strength, MPa	2	01	≤20	>20–50	>50–100	>100–200	>200–400	>400–1000	>1000			
Shear strength, MPa	2	02	≤20	>20–50	>50–100	>100–200	>200–400	>400–1000	>1000			
Compressive strength, MPa	2	03	≤20	>20–50	>50–100	>100–200	>200–400	>400–1000	>1000–2000	>2000–4000	>4000–10 000	
Toughness	2	04	Important characteristic of product									
Hardness, HV1.0, HK1.0, or HK2.0	2	05	≤1000	>1000–1500	>1500–2000	>2000						
Young's modulus, GPa	2	06	≤50	>50–100	>100–200	>200–400	>400					
Tensile strength, MPa	2	07	≤20	>20–50	>50–100	>100–200	>200–400	>400–1000	>1000			
Poisson's ratio	2	08	≤0.1	>0.1–0.15	>0.15–0.2	>0.2–0.25	>0.25–0.3	>0.3				
Thermal Properties	3		Product displays thermal properties critical to its function									
Thermal conductivity, $W\ m^{-1}\ K^{-1}$	3	01	≤2	>2–4	>4–10	>10–30	>30–50	>50				
Specific heat, $J\ g^{-1}\ K^{-1}$	3	02	≤0.3	>0.3–0.5	>0.5–0.7	>0.7–1.0	>1.0					
Water quench thermal shock resistance, ΔT, K	3	03	≤100	>100–200	>200–400	>400						

TABLE A4.1 *Continued*

Property and Type	j	k_1k_2	1	2	3	4	5	6	7	8	9	Test Method A=monolithic B=composites C=coatings D=powders
Coefficient of thermal expansion, 10^{-6} K^{-1}[A]	3	04	≤2	>2–4	>4–8	>8–10	>10–20	>20				
Self-loaded deformation temperature in air, °C	3	05	≤200	>200–500	>500–800	>800–1000	>1000–1200	>1200–1600	>1600			
Glass transition temperature, °C	3	06	≤200	>200–300	>300–400	>400–500	>500–600	>600–700	>700–800	>800		
Optical Properties	4		Product displays optical properties critical to its function									
Refractive index	4	01	Important characteristic of product									
Transmittance	4	02	Important characteristic of product									
Color	4	03	Important characteristic of product									
Birefringence	4	04	Important characteristic of product									
Magnetic Properties	5		Product displays magnetic properties critical to its function									
Permeability	5	01	Important characteristic of product									
Remanence	5	02	Important characteristic of product									
Coercivity	5	03	Important characteristic of product									
Ferromagnetic	5	04	Important characteristic of product									
Diamagnetic	5	05	Important characteristic of product									
Magnetostrictive properties	5	06	Important characteristic of product									
Electrical Properties	6		Product displays electrical properties critical to its function									
Resistivity (electronic), Ω cm	6	01	$\leq 10^{14}$	$<10^{14}$–10^{10}	$<10^{10}$–10^{6}	$<10^{6}$–10^{3}	$<10^{3}$–10^{1}	$<10^{1}$–10^{-1}	$<10^{-1}$			
Nonlinear resistivity	6	02	Important characteristic of product									
Superconductivity, critical temperature	6	03	Important characteristic of product									
Superconducting critical current	6	04	Important characteristic of product									
Resistivity (ionic)	6	05	Important characteristic of product									
Permitivity	6	06	≤5	>5–8	>8–12	>12–20	>20–100	>100–500	>500–2000	>2000		
Temperature coefficient of permittivity	6	07	Important characteristic of product									
Ferroelectric transition temperature	6	08	Important characteristic of product									
Loss tangent	6	09	≥0.1	<0.1–0.01	<0.01–0.001	<0.001–10^{-4}	$<10^{-5}$					
Dielectric breakdown voltage gradient, kV mm^{-1}	6	10	≤5	>5–10	>10–20	>20–40	>40					
Pyroelectric properties	6	11	Important characteristic of product									
Thermoelectric characteristics	6	12	Important characteristic of product									
Negative temperature coefficient	6	13	Important characteristic of product									
Positive temperature coefficient	6	14	Important characteristic of product									
Piezoelectric characteristics	6	15	Important characteristic of product									
Electrorestrictive characteristics	6	16	Important characteristic of product									

TABLE A4.1 *Continued*

Property and Type	j	k_1k_2	1	2	3	4	5	6	7	8	9	Test Method A=monolithic B=composites C=coatings D=powders
Electro-optic	6	17	Important characteristic of product									
Wear resistance	7		Product displays wear-resistant properties critical to its function									
Abrasive wear resistance	7	01	Important characteristic of product									
Sliding wear resistance	7	02	Important characteristic of product									
Elusive wear resistance	7	03	Important characteristic of product									
Corrosion resistance	8		Product is specifically designed for resistance to corroding media									
Water	8	01	Important characteristic of product									
Acid solutions	8	02	Important characteristic of product									
Alkali solutions	8	03	Important characteristic of product									
Oxidizing gases	8	04	Important characteristic of product									
Reducing gases	8	05	Important characteristic of product									
Other vapors	8	06	Important characteristic of product									
Molten metals	8	07	Important characteristic of product									
Molten salts	8	08	Important characteristic of product									
Molten siliceous slags	8	09	Important characteristic of product									
Biological resorbability	8	20	Important characteristic of product									
Biological inertness	8	21	Important characteristic of product									
Biological reactivity (not resolvable)	8	22	Important characteristic of product									

[A]For thermal expansion, the temperature qualifier shall always be used to indicate the range room temperature over which the data apply.

TABLE A4.2 Property Data Codes *m* and *n*

Property Data Code *m* or *n*	Temperature qualifier, °C (Element *m*)	Frequency qualifier, Hz (Element *n*)
1	≤0	dc
2	>0 ≤ 100	$\leq 10^3$
3	>100 ≤ 300	$>10^3 \leq 10^6$
4	>300 ≤ 600	$>10^6 \leq 10^9$
5	>600 ≤ 900	$>10^9$
6	>900 ≤ 1200	. . .
7	>1200 ≤ 1400	. . .
8	>1400 ≤ 1600	. . .
9	>1600	. . .
0	not defined	not defined

A5. PRODUCT ORIGIN CLASSIFICATION FIELDS

A5.1 This field is uniquely identified by the initial letter *R*. The field is intended to identify the place and date of product manufacture.

A5.2 The code for the place of manufacture is based on the international telephone code and consists of a country and city (or local region) numeric identifier string. The date of manufacture is identified by a 2-digit number corresponding to the month (January = 01, December = 12) and by a 4-digit number corresponding to the year (19yy; 20yy).

The coding format for this descriptor will be:

Rnnnnbbbbxxyyyy

where:

nnnn = country code,
bbbb = local area code,
xx = month code, and
yyyy = year code.

Note that the local area code cannot be listed unless the country code is given also.

A5.3 The list given in Table A5.1 indicates major country (C) and local area (LA) codes:

TABLE A5.1 Major Country (C) and Local Area (LA) Codes

Argentina		
C:	0054	
LA:	Bahia Blanca	0091
	Buenos Aires	0001
	Cordoba	0051
	La Plata	0021
	Mar Del Plata	0023

TABLE A5.1 *Continued*

	Mendoza	0061
	Rosario	0041
	San Juan	0641
	Santa Fe	0042
	Other	1000
Australia		
C:	0061	
LA:	Adelaide	0008
	Albury	0060
	Bathurst	0063
	Brisbane	0007
	Cairns	0070
	Canberra	0062
	Darwin	0089
	Geelong	0052
	Hobart	0002
	Kalgoorlie	0090
	Melbourne	0003
	Newcastle	0049
	Perth (WA)	0009
	Sydney	0002
	Townsville	0077
	Other	1000
Austria		
C:	0043	
LA:	Baden Wien	2252
	Beregenz	5574
	Dornbrn	5572
	Eisenstadt	2682
	Feldkirch	5522
	Gmunden	7612
	Graz	0316
	Innesbruck	5222
	Kitzbuhel	5356
	Klagenfurt	4222
	Leoben	3842
	Linz Donau	0732
	Salzburg	0662
	St. Gallen	3632
	St. Polten	2742
	Steyr	7252
	Vienna	0222
	Villach	4242
	Wels	7242
	Wienernaustadt	2622
	Other	1000
Belgium		
C:	0032	
LA:	Aaist	0053
	Antwerp	0003
	Arlon	0063
	Bruges	0050
	Brussels	0002
	Charleroi	0071
	Coutral	0056
	Deurne	0013
	Eupen	0087
	Ghent	0091
	Liege	0041
	Louvain	0016
	Malines	0015
	Mons	0065
	Namur	0081
	Ostende	0059
	St. Nicholas	0041
	Tournai	0069
	Turnhout	0014
	Verviers	0087
	Wavre	0010
	Zeebrugge	0050
	Other	1000
Brazil		
C:	0055	
LA:	Belem	0091
	Belo Horizonte	0031
	Brasilia	0061

TABLE A5.1 *Continued*

	Fortaleza	0085
	Recife	0081
	Riberao Preto	0016
	Rio de Janiero	0021
	Salvador	0071
	Sao Paulo	0011
	Other	1000
Canada		
C:	0001	
LA:	Alberta	0403
	Yukon Territory	0403
	British Columbia	0604
	Manitoba	0204
	New Brunswick	0506
	Newfoundland	0709
	N.W. Territory	0604
	Nova Scotia	0902
	Prince Edward Isl.	0902
	Ontario:	
	Fort William	0807
	Thunder Bay	0807
	London	0519
	North Bay	0705
	Ottawa	0613
	Toronto	0416
	Quebec:	
	Montreal	0514
	Quebec	0418
	Sherbrooke	0819
	Saskatchewan	0306
	Other	1100
China		
C:	0086	
LA:	Shenyang	0024
	Other	1000
Cyprus		
C:	0357	
LA:	Agros	0056
	Deftera	0026
	Dhali	0025
	Evdimou	0052
	Larnaca	0041
	Limassol	0051
	Nicosia	0021
	Ormidhia	0047
	Paphos	0061
	Peyie	0066
	Platres	0054
	Polis	0063
	Other	1000
Denmark		
C:	0045	
LA:	Aalborg	0008
	Arhus	0006
	Copenhagen	0001
	Esbjerg	0005
	Fredericia	0005
	Grenaa	0006
	Helsingor	0002
	Horsens	0005
	Kolding	0005
	Naestved	0003
	Odense	0009
	Randers	0006
	Roskilde	0002
	Vejie	0005
LA:	Viborg	0006
	Other	1000
Ecuador		
C:	0593	
LA:	Ambato	0002
	Cuenca	0004
	Guayaquil	0004
	Machala	0004
	Manta	0004
	Quito	0002

TABLE A5.1 *Continued*

	Other	1000
Finland		
C:	0358	
LA:	Hameenlinna	0017
	Hamina	0052
	Helsinki	0000
	Hyrvinkaa	0014
	Imatra	0054
	Joensuu	0073
	Jyvaskyla	0041
	Kemi	0080
	Kotka	0052
	Kuopio	0071
	Lahti	0018
	Lappeenranta	0053
	Mikkeli	0055
	Oulu	0081
	Pori	0039
	Porvoo-Borga	0015
	Tampere	0031
	Turku-Abo	0021
	Vaasa-Vas	0061
	Other	1000
France		
C:	0033	
LA:	Amiens	0022
	Angers	0041
	Angouleme	0045
	Antibes	0093
	Avignon	0090
	Besancon	0081
	Biarritz	0059
	Bordeaux	0056
	Boulogne	0021
	Brest	0098
	Calais	0021
	Cannes	0093
	Cherbourg	0033
	Clermont	0073
	Dieppe	0035
	Dijon	0080
	Douai	0027
	Dunkirk	0028
	Grenoble	0076
	Le Havre	0035
	Lille	0020
	Limoges	0055
	Lyon	0007
	Marseille	0091
	Menton	0093
	Montbeliard	0081
	Montpelier	0067
	Nantes	0040
	Nice	0093
	Paris	0001
	Perpignan	0068
	Reims	0026
	Rouen	0035
	St. Quentin	0023
	St. Tropez	0094
	Strasbourg	0088
	Toulon	0094
	Toulouse	0061
	Tourcoing	0020
	Tours	0047
	Versailles	0003
	Other	1000
Germany		
C:	0049	
LA:	Aachen	0241
	Augsburg	0821
	Berlin	0030
	Bielefeld	0521
	Bochum	0234
	Bonn	0228
	Bottrop	2041

TABLE A5.1 *Continued*

	Braunschweig	0531
	Bremen	0421
	Bremerhaven	0471
	Cologne	0221
	Darmstadt	6151
	Dortmund	0231
	Duisberg	0203
	Dusseldorf	0211
	Essen	0201
	Frankfurt	0069
	Freiburg-im-Breisgau	0761
	Gelsenkirchen	0209
	Hagan	2231
	Hamburg	0040
	Hannover	0511
	Heidelberg	6221
	Herne	2323
	Karlsruhe	0721
	Kassel	0561
	Kiel	0431
	Koblenz	0261
	Krefeld	2151
	Leverkusen	0214
	Lubeck	0451
	Mainz	6131
	Mannheim	0621
	Monchengladback	2161
	Munich	0089
	Munster	0251
	Neuss	2101
	Nuremburg	0911
	Oberhausen	0208
	Offenbach	0611
	Oldenburg	0441
	Osanbruck	0541
	Regensburg	0941
	Stuttgart	0711
	Wuppertal	0202
	Wurzburg	0931
	Other	1000
Greece		
C:	0030	
LA:	Alexandroupolis	0551
	Arta	0681
	Athens	0001
	Chios	0271
	Corfu	0661
	Iralkion Kritis	0081
	Kalamata	0721
	Kavala	0051
	Larssa	0041
	Mytilini	0251
	Patrai	0061
	Piraeus	0001
	Pyrgos Ilias	0621
	Rhodes	0241
	Syros	0281
	Thessaloniki	0031
	Tripolis	0071
	Volos	0421
	Zakynthos	0695
	Other	1000
Hong Kong		
C:	0852	
LA:	Hong Kong	0005
	Kowloon	0003
	Lantau	0005
	New Territory	0000
	Other	1000
Hungary		
C:	0036	
LA:	Budapest	0001
	Debrecen	0052
	Cegled	0020
	Gyongyos	0037
	Gyor	0096

TABLE A5.1 *Continued*

	Kaposvar	0082
	Miskolc	0046
	Nyiregyhaza	0042
	Pecs	0072
	Sopron	0099
	Szeged	0062
	Szeksfehervar	0022
	Szolnok	0056
	Szombathely	0094
	Veszprem	0080
	Zalaegerseg	0092
	Other	1000
Iceland		
C:	0354	
LA:	Akureryi	0006
	Akranes	0003
	Flatevri	0004
	Hafnarfjoedur	0001
	Husavik	0006
	Isafjoedur	0004
	Keflavik	0002
	Kopavogur	0001
	Neskaupstadur	0007
	Olafdfjoerdur	0006
	Patreksjoedur	0004
	Reykjavik	0001
	Saudarkrokur	0005
	Seydisjoedur	0007
	Sigfuatjoedur	0006
	Vestmannaeyjar	0008
	Other	1000
India		
C:	0091	
LA:	Ahmadabad	0272
	Bangalore	0812
	Bombay	0022
	Calcutta	0033
	Hyderabad	0842
	Madras	0044
	New Delhi	0011
	Other	1000
Indonesia		
C:	0062	
LA:	Balik Papan	0542
	Bandung	0022
	Banyuwangi	0333
	Jakarta	0021
	Manado	0431
	Medan	0081
	Padang	0751
	Palembang	0711
	Pamekasan	0324
	Semarang	0024
	Surabaya	0031
	Tegal	0283
	Other	1000
Ireland		
C:	0353	
LA:	Cork	0021
	Dublin	0001
	Dundulk	0042
	Galway	0091
	Limerick	0061
	Waterford	0051
	Other	1000
Israel		
C:	0972	
LA:	Acre	0004
	Afula	0066
	Ashdod	0055
	Ashquelon	0051
	Bat Iam	0003
	Beer Sheva	0057
	Benei Berak	0003
	Elat	0059
	Givataim	0003

TABLE A5.1 *Continued*

	Hadera	0063
	Haifa	0004
	Holon	0003
	Jerusalem	0002
	Nazareth	0065
	Netanya	0053
	Petah Tiqwa	0003
	Ranla	0008
	Ramat Gan	0003
	Rehovot	0008
	Safed	0067
	Tel Aviv	0003
	Tiberias	0067
	Zarnuga	0003
	Other	1000
Italy		
C:	0039	
LA:	Bari	0080
	Bologna	0051
	Bolzano	0471
	Brescia	0030
	Cagliari	0070
	Capri	0081
	Catania	0095
	Como	0031
	Florence	0055
	Genoa	0010
	Livorno	0586
	Messina	0090
	Milan	0002
	Modena	0059
	Naples	0081
	Padua	0049
	Palermo	0091
	Parma	0521
	Perugie	0075
	Pescara	0085
	Pisa	0050
	Rimini	0541
	Rome	0006
	Salerno	0089
	San Remo	0184
	Siracusa	0931
	Taranto	0099
	Terni	0744
	Trieste	0040
	Turin	0011
	Venice	0041
	Verona	0045
	Vicenza	0444
	Other	1000
Japan		
C:	0081	
LA:	Akita	0188
	Aomori	0177
	Chiba	0472
	Fukuoka	0092
	Hiroshima	0082
	Kawasaki	0044
	Kitakyusha	0093
	Kobe	0078
	Kyoto	0075
	Kure	0823
	Nagasaki	0958
	Nagoya	0052
	Naha	0988
	Okayama	0862
	Omiya	0486
	Osaka	0006
	Sakai	0722
	Sapporo	0011
	Sendai	0222
	Tokyo	0003
	Toyama	0764
	Toyonaka	0006
	Urawa	0488

TABLE A5.1 *Continued*

	Yokohama	0045
	Yokosuka	0468
	Other	1000
Korea		
C:	0082	
LA:	Andong	0571
	Anyang	0343
	Busan	0051
	Chuncheon	0361
	Daegu	0053
	Daejeon	0042
	Euijeongbu	0351
	Gwangju	0062
	Incheon	0032
	Iri	0653
	Jeju	0641
	Jeonju	0652
	Masan	0551
	Magpo	0631
	Seoul	0002
	Ulsan	0522
	Weonju	0371
	Yeosu	0662
	Other	1000
Libya		
C:	0218	
LA:	Ajdabyan	0064
	Benghazi	0061
	Benina	0063
	Derna	0081
	Misutata	0051
	Sebha	0071
	Sabratha	0024
	Tobruk	0087
	Tripoli	0021
	Tripoli Int Air	0022
	Zawai	0023
	Zuara	0025
	Other	1000
Malaysia		
C:	0060	
LA:	Ipoh	0005
	Kota Kinabalu	0088
	Kuala Lumpur	0003
	Kuching	0082
	Malacca	0006
	Penang	0004
	Sandakan	0089
	Taiping	0005
	Other	1000
Netherlands		
C:	0031	
LA:	Amstelveen	0020
	Amsterdam	0020
	Apeldoorn	0055
	Arnhem	0085
	Bilthoven	0030
	Breda	0076
	Delft	0015
	Dordrecht	0078
	Eindhoven	0040
	Enschede	0053
	Goirle	0013
	Gravenhage	0070
	Haarlem	0023
	Hague, The	0070
	Heemstede	0023
	Heerlen	0045
	Hook of Holland	1747
	Kerkrade	0045
	Leeuwarden	0058
	Leiden	0071
	Maastricht	0043
	Nijmegen	0080
	Rotterdam	0010
	Scheveningen	0070

TABLE A5.1 *Continued*

	Schiedam	0010
	Tilburg	0013
	Ulvenhout	0076
	Ultrecht	0030
	Venio	0077
	Vlaardingen	0010
	Voorburg	0070
	Zaandam	0075
	Zwolle	5200
	Other	1000
Netherland Antilles		
C:	0599	
LA:	Bonaire	0007
	Curacao	0009
	Saba	0004
	St. Eustatius	0003
	St. Maarten	0005
	Other	1000
New Zealand		
C:	0064	
LA:	Ashburton	0053
	Auckland	0009
	Blenheim	0057
	Christchurch	0003
	Dunedin	0024
	Gisborne	0079
	Gore	0020
	Hamilton	0071
	Hastings	0070
	Invercargill	0021
	Masterton	0059
	Napier	0070
	Nelson	0054
	New Plymouth	0067
	Palmerston N.	0063
	Rotorua	0073
	Taupo	0074
	Tauranga	0075
	Timaru	0056
	Wanganui	0064
	Wellington	0004
	Other	1000
Norway		
C:	0047	
LA:	Alesund	0071
	Bergen	0005
	Kongsberg	0003
	Kristiansand	0042
	Oslo	0002
	Sandefjord	0034
	Sandnes	0004
	Stavanger	0004
	Trondheim	0007
	Other	1000
Philippines		
C:	0063	
LA:	Bacolod	0034
	Cabanataun	4797
	Caloocan	0002
	Cebu	0032
	Dagupan	0048
	Davao	0035
	Iloilo	0033
	Manila	0002
	Pasay City	0002
	Quezon City	0002
	San Fernando Pangasinan	0045
	San Fernando La Union	0046
	San Pablo	0043
	Other	1000
Poland		
C:	0048	
LA:	Bydgoszcz	0052
	Krakow	0012

TABLE A5.1 *Continued*

	Lodz	0042
	Lublin	0081
	Poznan	0061
	Szczecin	0091
	Warsaw	0022
	Wroclaw	0071
	Other	1000
Portugal		
C:	0351	
LA:	Albufeira	0089
	Almada	0001
	Amarante	0055
	Barreiro	0001
	Beja	0084
	Braga	0053
	Castelo Branco	0072
	Chaves	0076
	Coimbra	0039
	Fundao	0075
	Gondomar	0002
	Guarda	0071
	Leiria	0044
	Lisbon	0001
	Loule	0089
	Oporto	0002
	Santarem	0043
	Setubal	0065
	Torres Vedras	0061
	Viana do Castelo	0058
	Viseu	0032
	Other	1000
Romania		
C:	0040	
LA:	Brasov	0021
	Bucharest	0000
	Cluj-Napoca	0051
	Iasi	0081
	Ploiesti	0071
	Timisoara	0061
	Other	1000
Saudi Arabia		
C:	0966	
LA:	Holuf	0003
	Jeddah	0002
	Mecca	0002
	Medina	0004
	Riyadh	0001
	Other	1000
South Africa		
C:	0027	
LA:	Bloemfontein	0051
	Cape Town	0021
	Durban	0031
	East London	0431
	Johannesburg	0011
	Parou	0021
	Port Elizabeth	0041
	Pretoria	0012
	Other	1000
Spain		
C:	0034	
LA:	Alicante	0065
	Almeria	0051
	Barcelona	0003
	Benidorm	0065
	Bibao	0004
	Granada	0058
	Ibiza	0071
	Las Palmas	0028
	Madrid	0001
	Malaga	0052
	Murcia	0068
	Palma (Majorca)	0071
	Sabadell	0003
	Santa Cruz (Tenerife)	0022
	Santander	0042

TABLE A5.1 *Continued*

	Seville	0054
	Torremolinos	0052
	Valencia	0006
	Vallodoid	0083
	Vigo	0086
	Vitoria	0045
	Other	1000
Sweden		
C:	0046	
LA:	Gothenburg	0031
	Helsingborg	0042
	Linkoping	0013
	Malmo	0040
	Norrkoping	0011
	Orebro	0019
	Stockholm	0008
	Uppsala	0018
	Vasteras	0021
	Other	1000
Switzerland		
C:	0041	
LA:	Basle	0061
	Berne	0031
	Geneva	0022
	Interlaken	0036
	Lausanne	0021
	Lucerne	0041
	St. Gallen	0071
	St. Moritz	0082
	Sion	0027
	Winterthur	0052
	Zug	0042
	Zurich	0001
	Other	1000
Taiwan		
C:	0886	
LA:	Kaohsiung	0007
	Taipei	0002
	Other	1000
Thailand		
C:	0066	
LA:	Bangkok	0002
	Thonburi	0002
	Other	1000
Turkey		
C:	0090	
LA:	Adana	0071
	Ankara	0041
	Antalya	3111
	Aydin	6311
	Bafra	3751
	Bursa	0241
	Cankiri	4671
	Denizli	6211
	Edirne	1811
	Erzurum	0011
	Eskisehir	0211
	Gaziantep	0851
	Iskenderum	8811
	Isparta	0327
	Istanbul	0001
	Izmir	0051
	Izmit	0211
	Kayseri	0351
	Konya	0331
	Malayta	8211
	Mersin	0741
	Samsun	0361
	Tekirdag	1861
	Van	0611
	Zonguldak	3811
	Other	1000
United Arab Emirates		
C:	0971	
LA:	Abu Dhabi	0002
	Ajman	0006

TABLE A5.1 *Continued*

	Al Ain	0003
	Aweer	0048
	Dubai	0004
	Fujairah	0070
	Jebel Ali	0084
	Jebel Dhana	0052
	Khorfakkan	0070
	Ras Al Kaimah	0077
	Sharjah	0006
	Umm Al Qaiwain	0006
	Other	1000
United Kingdom		
C:	0044	
LA:	Belfast, N. Ir	0232
	Briston, Eng	0272
	Cardiff, Wales	0222
	Edinburgh, Scot	0031
	Glasgow, Scot	0041
	Liverpool, Eng	0051
	London, Eng	0001
	Manchester, Eng	0061
	Sheffield, Eng	0742
	Southhampton, Eng	0703
	Other	1000
United States		
C:	0001	
LA:	Alabama	0205
	Alaska	0907
	Arizona	0602
	Arkansas	0501
	California:	
	Anaheim	0714
	Riverside	0714
	Bakersfield	0805
	Burbank	0818
	Van Nuys	0818
	Long Beach	0310
	Los Angeles	0213
	Oakland	0510
	Sacramento	0916
	San Diego	0619
	San Francisco	0415
	San Jose	0408
	Santa Rosa	0707
	Other	1000
	Colorado:	
	Boulder	0303
	Denver	0303
	Colorado Springs	0719
	Pueblo	0719
	Other	1001
	Connecticut	0203
	Delaware	0302
	Dist. of Columbia	0202
	Florida:	
	Boca Raton	0407
	Orlando	0407
	Ft. Lauderdale	0305
	Key West	0305
	Miami	0305
	Jacksonville	0904
	Tallahassee	0904
	St. Petersburg	0813
	Tampa	0813
	Other	1002
	Georgia:	
	Athens	0706
	Columbus	0706
	Atlanta	0404
	Macon	0912
	Savannah	0912
	Other	1003
	Hawaii	0803
	Idaho	0208
	Illinois:	
	Cairo	0618

TABLE A5.1 *Continued*

	Mt. Vernon	0618
	Chicago	0312
	Decatur	0217
	Springfield	0217
	Elgin	0708
	La Grange	0708
	La Salle	0815
	Rockford	0815
	Peoria	0309
	Other	1004
	Indiana:	
	Evansville	0812
	Gary	0219
	South Bend	0219
	Indianapolis	0317
	Other	1005
	Iowa:	
	Cedar Rapids	0319
	Dubuque	0319
	Council Bluffs	0712
	Sioux City	0712
	Des Moines	0515
	Other	1006
	Kansas:	
	Dodge City	0316
	Witchita	0316
	Kansas City	0913
	Topeka	0913
	Other	1007
	Kentucky:	
	Ashland	0606
	Lexington	0606
	Dade Park	0812
	Frankfort	0502
	Louisville	0502
	Other	1008
	Louisiana:	
	Baton Rouge	0504
	New Orleans	0504
	Lake Charles	0318
	Shreveport	0318
	Other	1009
	Maine	0207
	Maryland:	
	Annapolis	0410
	Baltimore	0410
	Salisbury	0410
	Cumberland	0301
	LaPlata	0301
	Rockville	0301
	Other	1010
	Massachusetts:	
	Boston	0617
	New Bedford	0617
	Plymouth	0508
	Worcester	0508
	Springfield	0413
	Other	1011
	Michigan:	
	Ann Arbor	0313
	Battle Creek	0616
	Detroit	0313
	Flint	0810
	Monroe	0313
	Grand Rapids	0616
	Kalamazoo	0616
	Jackson	0517
	Lansing	0517
	Saginaw	0517
	Sault Ste. Marie	0906
	Other	1012
	Minnesota:	
	Albert Lea	0507
	Rochester	0507
	Duluth	0218
	Minneapolis	0612

TABLE A5.1 *Continued*

St. Paul	0612
Other	1013
Mississippi	0601
Missouri:	
Independence	0816
Kansas City	0816
Jefferson City	0314
Springfield	0417
St. Louis	0314
Other	1014
Montana	0406
Nebraska:	
Lincoln	0402
Omaha	0402
North Platte	0308
Other	1015
Nevada	0702
New Hampshire	0603
New Jersey:	
Atlantic City	0609
Camden	0609
Trenton	0609
Elizabeth	0908
Woodbridge	0908
Jersey City	0201
Newark	0201
Other	1016
New Mexico	0505
New York:	
Albany	0518
Greenwich	0518
Schenectady	0518
Troy	0518
Binghampton	0607
Elmira	0607
Bronx	0718
Brooklyn	0718
Queens	0718
Staten Island	0718
Buffalo	0716
Rochester	0716
Hempstead	0516
Manhattan	0212
Monroe	0914
Mt. Vernon	0914
White Plains	0914
Niagara Falls	0716
Poughkeepsie	0914
Syracuse	0315
Other	1017
North Carolina:	
Charlotte	0704
Durham	0919
Raleigh	0919
Winston-Salem	0919
Other	1018
North Dakota	0701
Ohio:	
Akron	0216
Cleveland	0216
Youngstown	0216
Cincinnati	0513
Dayton	0513
Columbus	0614
Toledo	0419
Other	1019
Oklahoma:	
Muskogee	0918
Tulsa	0918
Oklahoma City	0405
Other	1020
Oregon	0503
Pennsylvania:	
Allentown	0215
Philadelphia	0215
Reading	0215

TABLE A5.1 *Continued*

	Altoona	0814
	Erie	0814
	Johnstown	0814
	Harrisburg	0717
	Hershey	0717
	Scranton	0717
	Wilks-Barre	0717
	Pittsburgh	0412
	Other	1021
	Rhode Island	0401
	South Carolina	0803
	South Dakota	0605
	Tennessee:	
	Chattanooga	0615
	Knoxville	0615
	Nashville	0615
	Memphis	0901
	Other	1022
	Texas:	
	Amarillo	0806
	Lubbock	0806
	Austin	0512
	Corpus Christi	0512
	San Antonio	0210
	Beaumont	0409
	Dallas	0214
	El Paso	0915
	Forth Worth	0817
	Waco	0817
	Houston	0713
	Tyler	0903
	Other	1023
	Utah	0801
	Vermont	0802
	Virginia:	
	Alexandria	0703
	Roanoke	0703
	Winchester	0703
	Norfolk	0804
	Portsmouth	0804
	Richmond	0804
	Other	1024
	Washington:	
	Olympia	0206
	Seattle	0206
	Tacoma	0206
	Vancouver	0206
	Spokane	0509
	Walla Walla	0509
	Other	1025
	West Virginia	0304
	Wisconsin:	
	Eau Claire	0715
	Green Bay	0414
	Milwaukee	0414
	Madison	0608
	Other	1026
	Wyoming	0307
Yugoslavia		
C:		0038
LA:	Banja Luka	0078
	Belgrade	0011
	Dubrovink	0050
	Kragujevac	0034
	Leskovac	0016
	Ljubljana	0061
	Novi Sad	0021
	Osijek	0054
	Pec	0039
	Rijeka	0051
	Sarajevo	0071
	Skopje	0091
	Split	0058
	Titograd	0081
	Zadar	0057
	Zagreb	0041

TABLE A5.1 *Continued*

	Other	1000
Zimbabwe		
C:	0038	
LA:	Bindura	0071
	Bulawayo	0009
	Chipinge	0037
	Gwanda	0084
	Gwerd	0054
	Garare	0000
	Karoi	0064
	Makuti	0063
	Mashava	0035
	Mutare	0020
	Norton	0072
	Rusape	0025
	Victoria Falls	0040
	Wankie	0049
	Other	1000
All Other Countries		
C:	9999	

APPENDIX

(Nonmandatory Information)

X1. WAYS CLASSIFICATION SYSTEM MAY BE USED TO DESCRIBE A RANGE OF MATERIALS AND APPLICATIONS

X1.1 Example 1

X1.1.1 Wire drawing die fabricated from yttria partially stabilized zirconia by isostatic pressing followed by green machining and sintering in air. After sintering, the components are finish ground and lapped. Product manufactured in London, England in May 1990. For this particular application the relevant properties are:

X1.1.1.1 High density,

X1.1.1.2 Small-grain size,

X1.1.1.3 High strength,

X1.1.1.4 High hardness, and

X1.1.1.5 Moderate elastic modulus.

X1.1.2 The full coding for this material/application based on this proposal would be as follows:

A361CKB0449MB0448P18P17P30P61P62D1017D1031D2016 D2052D2063R00440001051990

This is compiled as shown in Table X1.1.

X1.1.3 *Searching the Code*—For a full technical enquiry the full code may be desirable, however, for most users a truncated version will be more appropriate. For example, as Annex A2 suggests, for users wanting statistical information on ceramic goods, chemical character may be the most important feature, hence, a code as follows:

CKB0449MB0448

would give all the relevant information. Even this may be more information than is required. For example, if a user wants information solely on monolithic ceramics manufactured from zirconia (without specifying the existence or type of stabilizer) then the code CKB0449 conveys that information, and could be used to access the system.

TABLE X1.1 Compilation of Coding for Example 1

A361	Wire drawing die
CKB0449MB0448	Rigid (zero intentional porosity) ceramic body (KB) composed of zirconia (0449) in a chemical mixture (MB) with a minor undefined amount of yttria (0448) (Option 2, CKB 6645)
P18	Isostatically pressed
P17	Green machined
P30	Sintered in air
P61	Ground (fixed grit)
P62	Lapped
D1017	Density > 99 % of theoretical
D1031	Grain size $\leq$ 1 μm $\leq$ 1 μm
D2016	Flexural strength > 400 MPa (100 to 300°C)
D2052	Hardness 1000 to 1500 Vickers
D2063	Elastic modulus 100 to 200 GPa
R0044	(England) 0001 (London) 05 (May) 1990 (Year)

X1.1.3.1 In brochures and publicity literature the most important features are likely to be application and property data. Hence, for this use, the relevant form of the above code would be written as follows:

A361D1017D1031D20163D2052D2063

X1.1.3.2 Even this could be further simplified to give the application, together with only the most important (or most commonly associated) property, for example:

A361D20163

refers to the application (wire drawing die) and flexural strength at 100 to 300°C.

X1.1.3.3 Limitation of the property data information to the most relevant item would significantly reduce the length of the code strings but would raise the problem of identifying the items for inclusion. A possible solution would be to enter the data in the code in the order of the most important property (for a given application) first.

X1.2 Example 2

X1.2.1 Alumina substrate for thick-film applications manufactured by uniaxial pressing and sintering from a 96 %

alumina. In this particular application the relevant properties are:

X1.2.1.1 Flexural strength,

X1.2.1.2 Thermal conductivity,

X1.2.1.3 Thermal expansion,

X1.2.1.4 Volume resistivity, and

X1.2.1.5 Dielectric properties.

X1.2.2 The temperature of service, includiing processing, will be up to 600°C, and the frequency at which the associated components will be required to operate will be up to 1 MHz. The full code to describe this would be as follows:

A140CKB0407MEP16P30P58D1017D20151D30142D30446
D60124D603603D609425D6102

This is compiled as shown in Table X1.2.

X1.2.3 *Searching the Code*—As with the other worked examples, the full code will rarely be specified or required. Most users will restrict themselves to application and chemical character which in this case would give the following:

A140CKB0407ME or A140CKB5040

Further truncation of the code is, in this case, limited.

X1.3 Example 3

X1.3.1 Heating element supports for coiled wire heating elements manufactured in cordierite (as defined by IEC 500) by extrusion, green machining, and sintering. In this example, the material properties deemed to be important are:

X1.3.1.1 Density,

X1.3.1.2 Flexural strength,

X1.3.1.3 Thermal shock resistance,

X1.3.1.4 Thermal conductivity,

X1.3.1.5 Thermal expansion coefficient, and

X1.3.1.6 Volume resistivity.

X1.3.2 The full coding for this component would be written as follows:

A502CKG5950P26P30P61D1016D1022D20132D30112D3034
D30436D60134

This is compiled as shown in Table X1.3.

X1.4 Example 4

X1.4.1 Yttria stabilized zirconia powder supplied as a *ready to press* powder for advanced ceramics manufacture.

X1.4.2 In this case the important features of the product are its chemical character and process route.

TABLE X1.2 Compilation of Coding for Example 2

A140	Substrate for electronic components
CKB0407ME Monolithic ceramic (with zero intentional porosity) (KB) manufactured from alumina (0407) containing a trace of unspecified additive (ME) (Option 2 CKB5040)	
P16	Uniaxially pressed
P30	Sintered in air
P58	As manufactured finish
D1017	Density >99 %
D20151	Flexural strength at room temperature 200 to 400 MPa
D30142	Thermal conductivity at room temperature 10 to 30 W/mK
D30446	Thermal expansion coefficient at 1000°C 8 to 10 $\times$ 10^{-6}
D60124	Volume resistivity at 600°C 10^{+12} to 10^{+8} Ωcm
D606303	Permittivity at 1 MHz (no temperature specified) 8 to 12
D609425	Loss tangent at room temperature and at 1 MHz 10^{-3} to 10^{-4}
D6102	Dielectric strength 5 to 10 KV/mm

TABLE X1.3 Compilation of Coding for Example 3

A502	Coiled wire heater support
CKG5950 Cordierite >95 %	
P26	Auger extruded
P30	Sintered in air
P61	Ground surface
D1016	Density 95 to 99 % of theoretical
D1022	Porosity 1 to 5 %
D20132	Flexural strength at room temperature 50 to 100 MPa
D30112	Thermal conductivity at room temperature <2 W/mK
D3034	Thermal shock resistance—High
D30436	Thermal expansion coefficient at 1000°C 4 to 8 $\times$ 10^{-6}
D60134	Volume resistivity at 600°C 10^{+10} to 10^{+6} Ωcm

X1.4.3 The full code for this product would be as follows:

CEH0449MB0448P7P12

This is compiled as shown in Table X1.4.

X1.5 Example 5

X1.5.1 Boron-carbide-grit blasting nozzle manufactured by slip casting followed by sintering in a controlled atmosphere.

X1.5.2 The important properties for this application are defined as:

X1.5.2.1 Density,

X1.5.2.2 Flexural strength,

X1.5.2.3 Elastic modulus, and

X1.5.2.4 Abrasion resistance.

X1.5.3 The full code for this application would be written as follows:

A320CKB0203MEP19P31P58D1015D20151D2065D7012

This is compiled as shown in Table X1.5.

X1.6 Example 6

X1.6.1 Heating element support manufactured from vacuum-formed hardened and machined ceramic fiber block (for example KV 16 alumina fiber from Rath Fastertechnik Vertriebs).

X1.6.2 The properties identified as important for this application are as follows:

X1.6.2.1 Density,

X1.6.2.2 Flexural strength,

X1.6.2.3 Compressive strength,

X1.6.2.4 Thermal conductivity,

X1.6.2.5 Thermal shock resistance, and

X1.6.2.6 Maximum temperature of use.

The full code for this application would be written as follows:

A502CFV0407MEP28P45P62D1011D20112D20332D30118
D3034D3058

This is compiled as shown in Table X1.6.

TABLE X1.4 Compilation of Coding for Example 4[A]

CEH0449MB0448 Spray-dried powder granules (EH) of zirconia (0449) chemically mixed (MB) with yttria (0448)	
P7	Powder manufactured by chemical precipitation
P12	Granulated by spray drying

[A] In this instance, no information is contained in the application or property data descriptor fields, hence the field identifying Letters A and D are absent.

TABLE X1.5 Compilation of Coding for Example 5

A320	Shot blast nozzles
CKB0203ME	Rigid ceramic body (without intentional porosity) (KB) composed of boron carbide (0203) chemically mixed with an unspecified trace species (sintering aid) (Option CKB5511)
P19	Slip cast (unassisted)
P31	Sintered in a controlled (nonambient) atmosphere
P58	As-manufactured surface finish
D1015	Density 80 to 95 % of theoretical
D20151	Flexural strength at room temperature 200 to 400 MPa
D2065	Elastic modulus >400 GPa
D7012	Resistant to abrasive wear at room temperature

TABLE X1.6 Compilation of Coding for Example 6

A502	Support for heater rods
CFV0407ME	Vacuum-formed fiber block (FV) manufactured from alumina (0407) with a trace of unspecified additive (ME) (Option 2 CFV5030)
P28	Other green-forming route
P45	Chemical bonding
P62	Ground surface
D1011	Density <20 % of theoretical
D20112	Flexural strength at room temperature <20 MPa
D20332	Compressive strength at room temperature <100 MPa
D30118	Thermal conductivity at 1600°C <2 W/mK
D3034	Thermal shock resistance—High
D3058	Maximum temperature of use >1600°C