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Bibliography on Cermets (1945 – 1971)

A. Jesse

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Bibliography on Cermets (1945-1971)

by

Andreas Jesse *

Gesellschaft für Kernforschung m.b.H., Karlsruhe

* now at CERN, Sci.Inf.Service
CH-1211 Geneva 23

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Abstract

The bibliography contains some 3000 references on two-phase cermets. The arrangement is chronological (1945-1971) and alphabetical (first author), respectively.

An author index and a detailed subject index is included. The subject index lists the contents of every reference by means of descriptor strings with logic structure. The thesaurus of descriptors comprises the following fields: material(s), technology, properties, applications, and bibliographic information.

The distribution of the number of references with time, the main fields of application, and some basic problems related to the research and development of cermets are shortly discussed.

Abstrakt

Die Bibliografie enthält etwa 3000 Referenzen über zweiphasige Cermets. Die Anordnung ist chronologisch (1945-1971) bzw. alphabetisch (nach dem ersten Autor).

Ein Autoren- und ein ausführliches Sach-Verzeichnis sind vorhanden. Im Sach-Verzeichnis wird der Inhalt jeder Referenz durch Descriptor-Ketten mit logischer Struktur erschlossen. Das Descriptor-Vokabular ist nach folgenden Gebieten angeordnet: Material(ien), Technologie, Eigenschaften, Anwendungen und bibliografische Information.

Die zeitliche Verteilung der Zahl der Referenzen, die wichtigsten Anwendungsgebiete sowie grundlegende Probleme im Zusammenhang mit der Weiterentwicklung von Cermets werden kurz diskutiert.

Contents

1. Preface

Field Covered

C e r m e t s are composite materials that contain (at least) one ceramic and (at least) one metallic phase. Ceramic phase indicates a materials with mainly localized binding forces such as occur in oxides, sulphides, etc.

The references in this bibliography cover essentially the field of two-phase cermets, i.e. combinations of the type

$$M_I N_x\text{-}M_{II},$$

where M_I = a metal, N = a non-metal, M_{II} = a metal, x = stoichiometry (e.g. UO_2-Cu, ceramic $M_I N_x$ = urania, metal M_{II} = copper).

The composites treated here are usually m i c r o d i s p e r s e d systems (dispersions); the representative dimensions of the embedded phase are in the order of 1 to 100 µm (an exception is given by thin-film cermets).

Dispersion and precipitation hardened materials are not included, nor are laminated and fiber reinforced materials. The bibliography was confined to two-phase cermets in order to facilitate a relatively simple insight into composites.

Marginal references were evaluated when they seemed to be of interest to the field of cermets: e.g., the evaporation of metals on ceramics is of interest in the production of coated particles; porous ceramics may serve as models in theoretical considerations; phase diagrams and constitutional investigations give information on the compatibility of ceramic/metal combinations.

The arrangement of the references is by year of publication and, within each year, alphabetically by first author. Contributions by firms and such like are designated by "Anon." (anonymous author). The references are given in their original language if it is English, French, or German; otherwise, the titles are translated into English or German.
Papers read at conferences are only given in those cases where they seem not to have been published elsewhere. By including these unpublished papers, as well as patents, it is intended to give as complete a bibliography concerning the fields of research and development of cermets.

Information Sources

The references were found in abstracting periodicals that have a special heading like "cermets", "composites", or similar:

AED-AB, Informationen zur Kernforschung und Kerntechnik (since 1962)
Applied Science and Technology Index (since 1958)
Berichte der Deutschen Keramischen Gesellschaft (since 1920)
Ceramic Abstracts (since 1918)
Index Bibliographique de Chemie et Métallurgie des Matériaux Nucléaires (since 1965)
International Nuclear Information System, atomindex (since 1970)
Metallurgical Abstracts (since 1934)
Metals Abstracts (since 1968)
Nuclear Science Abstracts (since 1948)
Planseeberichte für Pulvermetallurgie (since 1953)

Cross-checking and complementing was done using the references no. 143, 953, 1328, 2001, and 2329.

Original contributions on cermets may be found especially in the following periodicals:

American Ceramic Society Bulletin (since 1922)
Composites (since 1969)
J. American Ceramic Society (since 1918)
J. Composite Materials (since 1967)
J. Nuclear Materials (since 1959)
Metal Progress (since 1912)
Microstructures (since 1970)
Nuclear Technology (since 1971)
Powder Metallurgy (since 1958)
Powder Metallurgy International (since 1969)
Soviet Powder Metallurgy and Metal Ceramics (since 1964)

Patents are given in, e.g.

brevatome (Atom Patents Abstracts) (since 1958)

Current classification numbers for cermets are

669.018.9 (Universal Decimal Classification)
B22f; C22 (International Patent Classification)

Findings and Conclusions

(1) Fig. 1 shows the variation of the number of references per year with time. As may be noted, this number was around 100/year in the period 1955/60; it became nearly twice as much ten years later.
The largest field of application of cermets is in nuclear engineering; the references on fuels, fuel elements, and thermionic emitters constitute 25 % of the total number.
Other applications of importance are as turbine materials (decreasing number of publications with time), as thin-film cermets (since 1965), cutting materials (41 references), rocket materials (40 ref.), electrical contacts (25 ref.), and friction materials (21 ref.).
20 % of the references are on (two-phase) cemented carbides, notably WC-Co and TiC-Co.

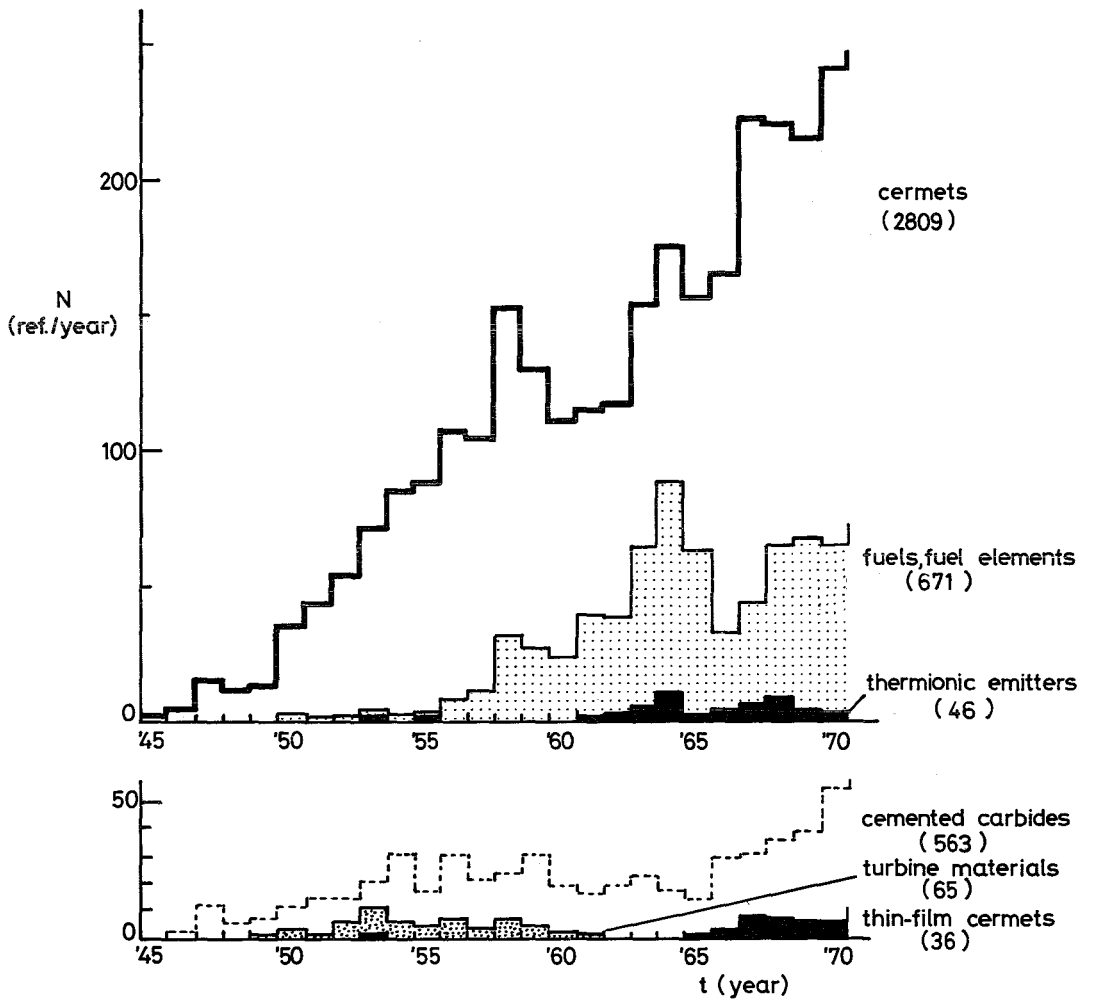

Fig.1 Variation of the number of references per year (N) with time (t) for different fields of application.
(The total number of references is indicated in parantheses)

(2) Table 2 on page 186 lists the ceramic/metal combinations and cermets that have been investigated. Among the ceramics (97), the oxides are dealt with most often; among the metals (46), the elements Fe, Co, Ni and Cr, Mo, W prevail. It can also be seen from this table that the 500 combinations investigated so far constitute only 11 % of all listed, possible systems (4462); of course, not all systems are of technical interest.

(3) For a further effective development of cermets, the following points need clarification:

- the definition as used in this bibliography (cf. references 2282, 2545, and 2907) is not yet generally adopted
- the models used for understanding and computing the physical properties of cermets in dependence of the microstructure are too idealized and need further refinement. Possible ways consist in the development of "model cermets" and the simulation of different models by means of computers
- the literature on cermets is spread very widely. There is a lack in recent reviews on technology, properties, and applications; these reviews would prove useful not only in the field of cermets but for composites in general (e.g., dispersion hardened materials, fiber reinforced materials, etc.). Finally, further authoritative data collections are needed.

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AUTHOR INDEX

SUBJECT INDEX

The contents of every reference is indicated by means of descriptors. In doing this, the questions posed were: which material combination has been investigated, how was it fabricated, which properties have been evaluated, where is the said material applied, and what information is available?

Thus, the descriptors were selected according to the following subject fields:

materials
technology
properties
applications
bibliographic information

(see Table 1, Guide to subject fields and descriptors, and Table 2, Ceramic-metal combinations and cermets which have been investigated).

'Physicochemical properties' are listed under 'materials' rather than under 'properties' because they deal with relations and reactions between ceramics and metals as such and not necessarily with cermets.
Normally, every paper on cermets gives details on its technology (i.e. preparation), density, and strength. These descriptors seem trivial and are only used when special or detailed investigations were performed.

Every reference is characterized by a string of descriptors. The structure of these strings is usually according to the procedures of research and development, i.e. materials, technology,... (as above). This structure has also been maintained wherever possible when listing the particular reference according to the second, third, ... descriptor. It should be noted, however, that the sequence of descriptors also carries some information; e.g.

microstructure mechanical properties WC-Co = relation between microstructure and mechanical properties; application to WC-Co

microstructure WC-Co mechanical properties = investigation of the microstructue of WC-Co; some mechanical properties have also been investigated

Every entry (except those dealing with composites, refractories and other similar materials) is about cermets; therefore the term 'cermet' has been omitted.
The subject index also lists several cross references in the form of

see and see also

Other explanations

(2624)	= this reference is a paper read at a conference; written documentation is most likely not available
Al2O3	= alumina cermet(s)
Al2O3-Co,-Cr,-Fe; TiO2...	= Al_2O_3-Co, Al_2O_3-Cr, Al_2O_3-Fe and TiO_2-Co, TiO_2-Cr, TiO_2-Fe cermets were investigated. Cermets separated by a semi-colon are treated as different descriptors; thus this combination is listed again as TiO2-Co,-Cr,-Fe; Al2O3...)
coated particles	= (ceramic) powder particles covered by a (metallic) layer
coating	= the technology of making coated particles or coating any other object
coatings	= resulting product (such as, surface coatings)
compatibility TiC-Co	= interactions and reactions between TiC and Co
constitution TiC-Co	= phase diagram Ti-Co-C, with special reference to the cermet TiC-Co
model	= specific model or a material configuration or combination that is suitable for the simulation for cermets (e.g., porous bodies, glass-bakelite composites)
patent +definition	= patent on a cermet; a definition of cermets is also given in the patent
review	= review article on cermets in general
review cemented carbides	= review article on cemented carbides
ss	= stainless steel

Grouping of descriptors has been done wherever possible; thus

bending strength creep fracture	are listed as	strength (bending) strength (creep) strength (fracture)

The structure of descriptors is as follows:

strength
strength (bending)
strength (bending)/high temperature/
strength /temperature/
strength, measurement
strength, theory

(...) for grouping

/.../ for specific additional information

The arrangement of the descriptor strings is alphabetical; e.g.,

TaC-Co
.....
thermal conductivity
.....
ThO2-Be
.....

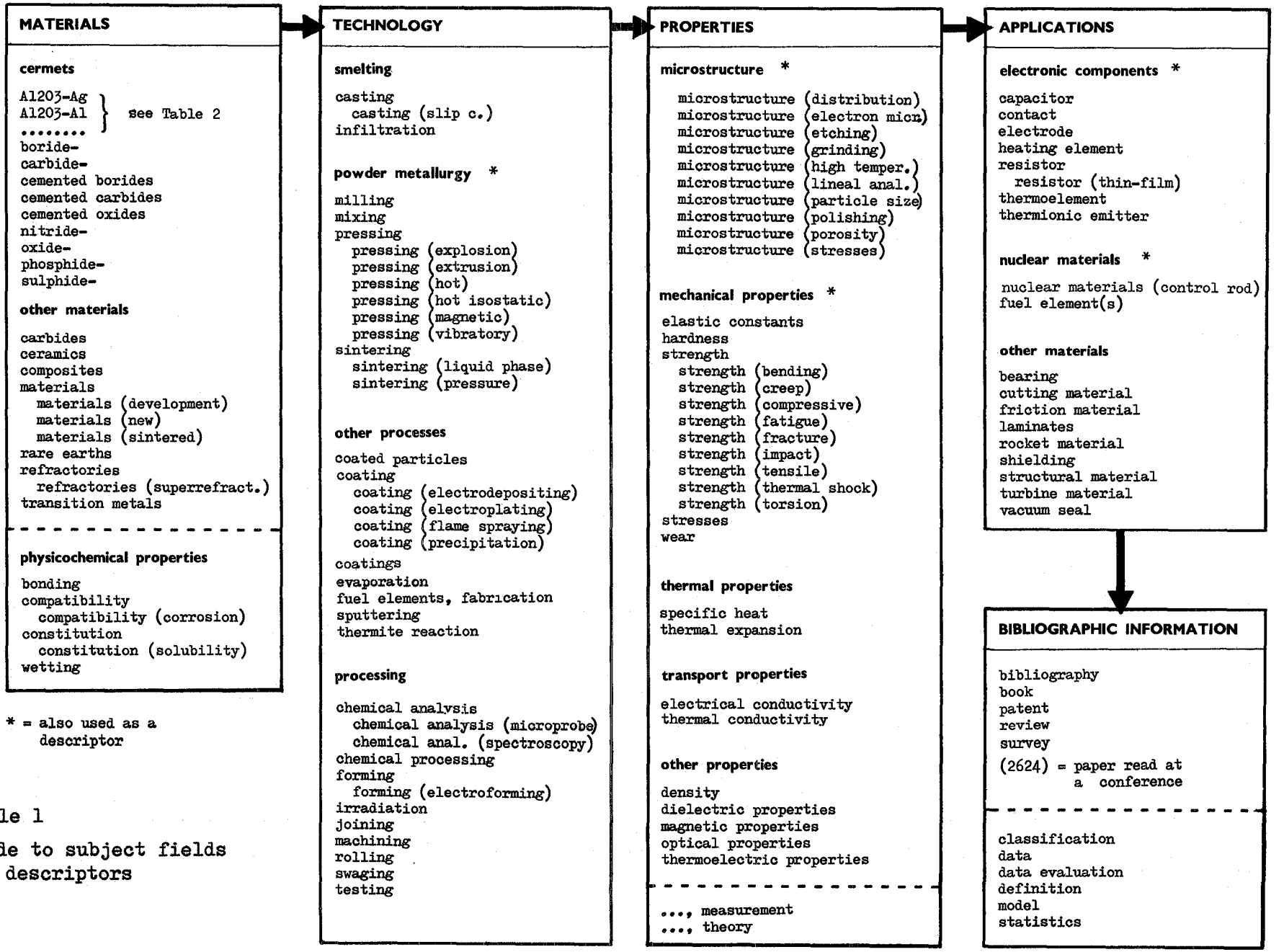
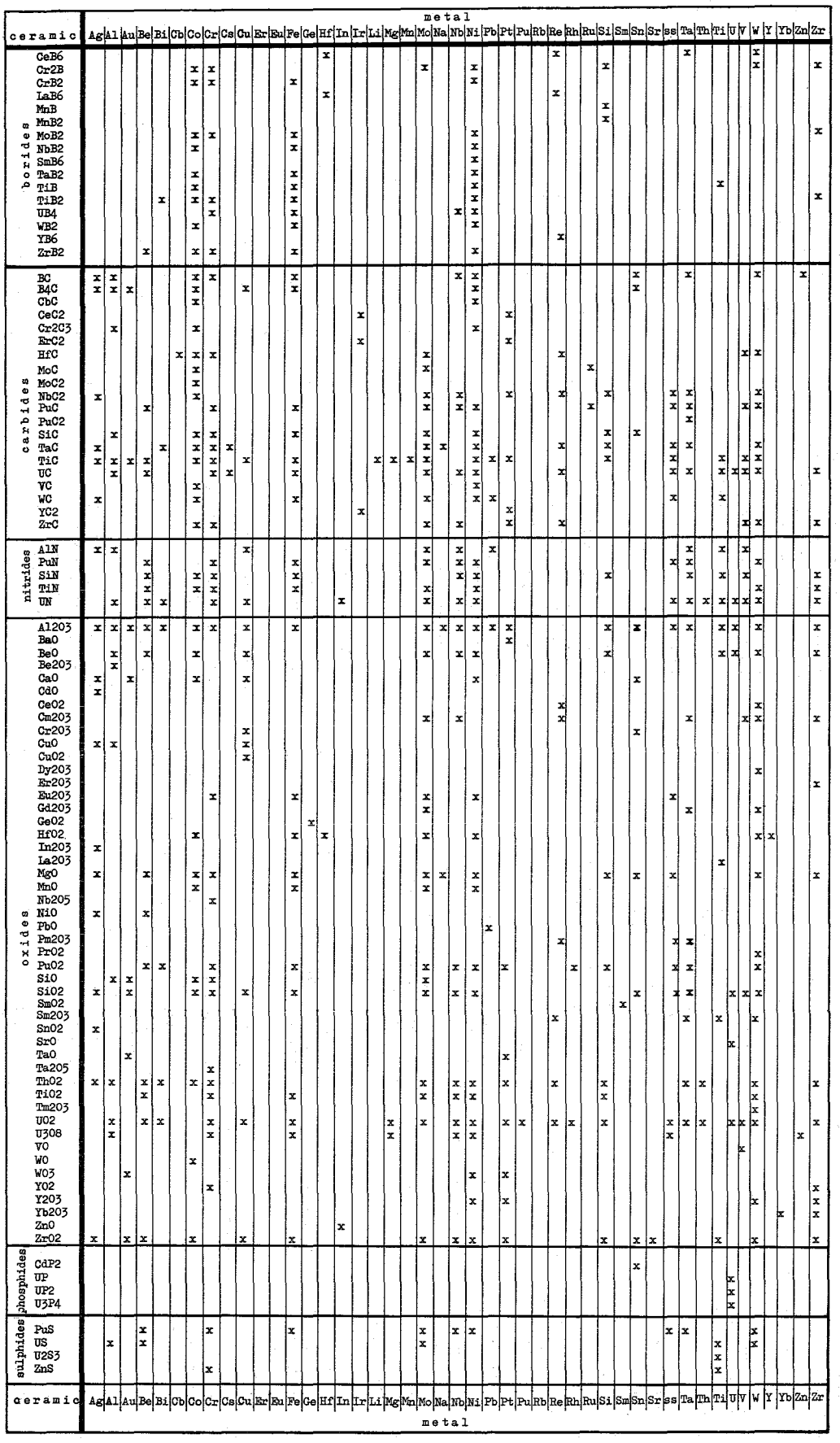


Table 1

Guide to subject fields and descriptors



alkali halides:

CaF2-Pu	KCl-K
LiF-Li	MgCl2-Mg
NaF-Na	NaCl-Na
RbF-Rb	PbCl2-Pb
	RbCl-Rb
KJ-K	KBr-K
NaJ-Na	
RbJ-Rb	

Table 2 Ceramic-metal combinations which have been investigated (also used as descriptors)