

HIGH TECH CERAMICS

Vol.3

MATERIALS SCIENCE MONOGRAPHS, 38C

HIGH TECH CERAMICS

**Proceedings of the World Congress on High Tech Ceramics,
the 6th International Meeting on Modern Ceramics Technologies
(6th CIMTEC), Milan, Italy, 24–28 June, 1986**

PART C

Edited by

P. VINCENZINI

National Research Council, Italy



ELSEVIER

Amsterdam – Oxford – New York – Tokyo

1987

ELSEVIER SCIENCE PUBLISHERS B.V.
Sara Burgerhartstraat 25
P.O. Box 211, 1000 AE Amsterdam, The Netherlands

Distributors for the United States and Canada:

ELSEVIER SCIENCE PUBLISHING COMPANY INC.
52, Vanderbilt Avenue
New York, NY 10017, U.S.A.

ISBN 0-444-42775-9 (Vol. 38C)
ISBN 0-444-41685-4 (Series)

© Elsevier Science Publishers B.V., 1987

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the publisher, Elsevier Science Publishers B.V./ Science & Technology Division, P.O. Box 330, 1000 AH Amsterdam, The Netherlands.

Special regulations for readers in the USA – This publication has been registered with the Copyright Clearance Center Inc. (CCC), Salem, Massachusetts. Information can be obtained from the CCC about conditions under which photocopies of parts of this publication may be made in the USA. All other copyright questions, including photocopying outside of the USA, should be referred to the copyright owner, Elsevier Science Publishers B.V., unless otherwise specified.

Printed in The Netherlands

MATERIALS SCIENCE MONOGRAPHS (Advisory Editor: C. LAIRD)

- Vol. 1 Dynamic Mechanical Analysis of Polymeric Material (Murayama)
Vol. 2 Laboratory Notes on Electrical and Galvanomagnetic Measurements (Wieder)
Vol. 3 Electrodeposition of Metal Powders (Călușaru)
Vol. 4 Sintering — New Developments (Ristić)
Vol. 5 Defects and Diffusion in Solids. An Introduction (Mrowec)
Vol. 6 Energy and Ceramics (Vincenzini)
Vol. 7 Fatigue of Metallic Materials (Klesnil and Lukáš)
Vol. 8 Synthetic Materials for Electronics (Jakowlew, Szymański and Włosifski)
Vol. 9 Mechanics of Aerospace Materials (Nica)
Vol. 10 Reactivity of Solids (Dyrek, Haber and Nowotny)
Vol. 11 Stone Decay and Conservation (Amoroso and Fassina)
Vol. 12 Metallurgical Aspects of Environmental Failures (Briant)
Vol. 13 The Use of High-Intensity Ultrasonics (Puškár)
Vol. 14 Sintering — Theory and Practice (Kolar, Pejovnik and Ristić)
Vol. 15 Transport in Non-Stoichiometric Compounds (Nowotny)
Vol. 16 Ceramic Powders (Vincenzini)
Vol. 17 Ceramics in Surgery (Vincenzini)
Vol. 18 Intergranular Corrosion of Steels and Alloys (Číhal)
Vol. 19 Physics of Solid Dielectrics (Bunget and Popescu)
Vol. 20 The Structure and Properties of Crystal Defects (Paidar and Lejček)
Vol. 21 Interrelations between Processing, Structure and Properties of Polymeric Materials (Seferis and Theocaris)
Vol. 22 Atmospheric Deterioration of Technological Materials: A Technoclimatic Atlas (Rychtera)
 Part A: Africa
 Part B: Asia (excluding Soviet Asia), Austràlia and Oceania
Vol. 23 Plasma Metallurgy (Dembovský)
Vol. 24 Fatigue in Materials: Cumulative Damage Processes (Puškár and Golovin)
Vol. 25 Sintered Metal — Ceramic Composites (Upadhyaya)
Vol. 26 Frontiers in Materials Technologies (Meyers and Inal)
Vol. 27 Joints with Fillet Welds (Faltus)
Vol. 28 Reactivity of Solids (Barret and Dufour)
Vol. 29 Progress in Advanced Materials and Processes: Durability, Reliability and Quality Control (Bartelds and Schliekelmann)
Vol. 30 Non-Ferrous Metals and Alloys (Sedláček)
Vol. 31 Defect Recognition and Image Processing in III–V Compounds (Fillard)
Vol. 32 The Si–SiO₂ System (Balk)
Vol. 33 Perspectives on Biomaterials (Lin and Chao)
Vol. 34 Silicon Nitride in Electronics (Belyi et al.)
Vol. 35 High Tech — The Way into the Nineties (Brunsch, Gölden and Herkert)
Vol. 36 Composite Systems from Natural and Synthetic Polymers (Salmén, de Ruvo, Seferis and Stark.)
Vol. 37 Copper Indium Diselenide for Photovoltaic Applications (Courtts, Kazmerski and Wagner)
Vol. 38 High Tech Ceramics (Vincenzini)
Vol. 39 Ceramics in Clinical Applications (Vincenzini)
Vol. 40 Electron Microscopy in Solid State Physics (Bethge and Heydenreich)

(3269)



1

PREFACE

In the last few years, the commercial importance of high tech ceramics has become more widely recognized, the main stimulus for interest in this class of high performance materials lying in their unique properties, which it is hoped will fulfill requirements for a large number of advanced systems and allow their optimization from the energy, structural and functional points of view.

Research on materials and development of processes has provided a decisive input for identifying emerging opportunities; wide new horizons are opening out for both basic research and processing science with the progress of knowledge in the field and with the need to meet the requirements of the scale-up of industrial processes in terms of materials performance in conventional and advanced systems. The multidisciplinary approach to the development of high performance ceramics is now recognized. Capability and expertise in fields formerly thought to be marginal or even extraneous are today important for the progress of advanced ceramics. What the coming years will hold for this class of materials will largely depend on the yield in terms of new knowledge and the cost-competitive, high performance materials that will result from investments in R&D programmes in operation internationally and on how the sectors where these materials are applied are stimulated to receive the new developments.

In this context, it was felt timely and appropriate to offer the international scientific community an interdisciplinary forum spanning the range from basic to applied research for the purpose of exchanging intersectorial experiences, reinforcing possible synergies and offering stimuli to possible users.

These were the objectives of the 6th CIMTEC-World Congress on High Tech Ceramics held in Milan (Italy), June 24-28, 1986. A particular characteristic of this meeting was that, for the first time in a ceramics congress organized in a western country, representatives were present from all the more important countries in both the eastern and western bloc countries, including the U.S.S.R.

The 370 or so scientific communications covered the more important aspects of basic research and studies of processing technologies as well as the impact of advanced ceramics on key industrial sectors, especially new applications in electronics, telecommunications, mechanical and production engineering, transportation and biotechnology. Present markets and their future development were also dealt with. A Panel Discussion specifically addressed present research programmes and national plans in high tech ceramics for a number of countries advanced in the sector.

The three volumes forming the Official Proceedings of the Congress contain most of the papers presented, with the exception of those given at the Satellite Symposium "Ceramics in Clinical Applications" which, because of their very

special nature, have been collected in a separate volume. The work of revision has been truly laborious both because of the entity of the material involved and because of the fact that a considerable number of the papers were written by authors unfamiliar with the English language and hence were difficult to understand. These papers have been either completely rewritten or at least partially reworked. Even so, in order to allow the scientific community to have access to the above material within a reasonable period of time, it was necessary to compromise somewhat and therefore accept certain papers containing linguistic and typographical imperfections, provided that the scientific content was sufficiently clear.

The World Congress on High Tech Ceramics, like preceding events in the CIMTEC series, was organized by Techna S.r.l. (Faenza, Italy) and was held under the auspices of the Italian Ministry for Science and Technology, ENEA, CNR, the Milan Chamber of Commerce, the City of Milan and the Lombard Region, and with the official involvement of the Academies of Science of the U.S.S.R. and Poland, the several Ceramic Associations ranking among the most important in the sector of high technology ceramics and the International Institute for the Science of Sintering. Invaluable help was received from these organizations, from the International Advisory Board and from the National Coordinating Committee in involving major government and industrial research institutes whose staff members presented the most recent and important results on their ongoing studies.

The Editor, who also acted as Chairman of the 6th CIMTEC, gratefully acknowledges the help provided by the sponsoring and cooperating organizations and by the I.A.B. and N.C.C. members. Sincere gratitude and appreciation are also expressed to C. Majani, Congress Vice-Chairman, to the executive staff of Techna S.r.l. and to the many other persons involved at various levels of responsibility in the congress organization for the quantity and quality of their efforts.

P. VINCENZINI



Italian Ministry for Science and Technology

C.N.R. National Research Council of Italy

E.N.E.A. Italian Commission for Nuclear and Alternative Energy

Sources

*Chambre of Commerce, Industry, Handicraft and Agriculture of Milan
Lombard Region
City of Milan*

Academy of Sciences of the USSR

American Ceramic Society

Australian Ceramic Society

British Ceramic Society

Chinese Ceramic Society

Dutch Ceramic Society

German Ceramic Society

Groupe Française de la Céramique

Japan Ceramic Society

Japan Fine Ceramics Association

Japan Society for Biomaterials

Polish Academy of Sciences

International Institute for the Science of Sintering

Society for Biomaterials

Société Française de la Céramique

Spanish Ceramic Society

Swedish Ceramic Society

Corporate co-sponsors and contributors:

*Asea Pressure Systems • Asea Cerama • Asea Metallurgy • Industrie Bitossi • Montedison
• Tecnobiomedica • A.V.X. Corporation • Siti • Tecnargilla*

HONORARY COMMITTEE

Luigi Granelli
Minister for Science and Technology
 Luigi Rossi Bernardi
President National Research Council
 Umberto Colombo
President Italian Commission for Nuclear and Alternative Energy Sources
 Piero Bassetti
President Milan Chambre of Commerce Industry, Handicraft and Agriculture
 Giuseppe Guzzetti
President Lombard Region
 Carlo Tognoli
Lord Mayor of Milan

BOARD OF REPRESENTATIVES OF COOPERATING ORGANIZATIONS

J.L. Anderson, Australia • Z. Bojarski, Poland • R.J. Brook, U.K. • D. Eugenio Azcarraga y Vela, Spain
 • P. Havranek, Sweden • A.S. Hoffman, USA • H. Kawahara, Japan • V.B. Lazarev, USSR •
 L. Lecrivain, France • H. Lehmann, FRG • R. Meiselaar, The Netherlands • J.L. Pentecost, USA •
 M.M. Ristic, Yugoslavia • S. Saito, Japan • S. Tabata, Japan • Yen Tung Sheng, China

Congress Chairman
 Pietro Vincenzini
 National Research Council, Italy

Vice Chairman
 Corrado Majani
 Italian Commission for Nuclear and Alternative Energy Sources, Italy

INTERNATIONAL ADVISORY BOARD

P. Boch, France • J.P. Boilot, France • R.C. Bradt, USA • A.J. Burggraaf, The Netherlands •
 R. Carlsson, Sweden • S. De Aza, Spain • R.J. Gottschall, USA • H. Hausner, FRG • K.H. Härdtl,
 FRG • A.H. Heuer, USA • E.D. Hondros, CEC Petten • T. Iseki, Japan • A. Kato, Japan • R.N. Katz,
 USA • W.D. Kingery, USA • E.K. Koehlert, USSR • M. Koizumi, Japan • D. Kolar, Yugoslavia •
 F.F. Lange, USA • S. Levine, USA • L.M. Levinson, USA • D.T. Livey, UK • M.G. McLaren, USA •
 K. Okazaki, Japan • D.R. Olander, USA • R. Pampuch, Poland • R. Pascard, France • R. Poeppel,
 USA • K.D. Reeve, Australia • B.C.H. Steele, UK • F. Thümmeler, FRG • R.E. Tressler, USA •
 R.R. Tummala, USA • M. Van De Voorde, The Netherlands

ITALIAN CO-ORDINATING COMMITTEE

L. Bianco • P.F. Bologna • C. Cardani • A. Collina • L. Donato • G. Elias • C. Majani • G. Morandi •
 G. Odone • L. Paris • C.E. Rossi • F. Savioli • P. Vincenzini • G.B. Zanchi

CONTENTS

PREFACE.....	V
SPONSORING ORGANIZATIONS.....	VII
CONGRESS COMMITTEES.....	VIII
OPENING LECTURES	
New ceramics: a strategic view- industrial, economic and societal impact	
U. Colombo and G. Lanzavecchia.....	3
Ceramic technology - Past, present, future	
W.D. Kingery.....	31
Present and future world market for high technology ceramics	
S. Saito.....	41
KEY AREAS IN HIGH TECH CERAMICS RESEARCH AND APPLICATION	
(General Invited Lectures)	
Phase diagrams for high tech ceramics	
S.J. Schneider, J.W. Hastie and W.P. Holbrook.....	59
Ceramics in microelectronics	
R.R. Tummala and R.B. Shaw.....	75
Ceramic sensors in the microprocessor industry	
N. Ichinose.....	95
Applications of ceramic electrolytes in electrochemical engineering systems	
B.C.H. Steele.....	105
Advanced ceramics in telecommunications	
H. Takata.....	121
Developments in transparent ceramics	
J.J. Aubert and Ph. Coeure.....	135
An assessment of the present status and future prospects of advanced ceramics in high temperature structural applications	
R. Nathan Katz.....	145

Aerospace ceramics: research and applications	
S.R. Levine, J.A. Di Carlo and J.D. Kiser.....	163
Ceramics in fission and fusion technology	
D.R. Olander.....	173
Ceramics in clinical applications, past, present and future	
S.F. Hulbert, J.C. Bokros, L.L. Hench, J. Wilson and G. Heimke.....	189

SECTION A: FUNDAMENTALS IN MATERIALS RESEARCH, PROCESSING SCIENCE AND TECHNOLOGY

A1. Basic Science

Mechanism of reactions in the $Si_1 + C_f$ system and the self-propagating high-temperature synthesis of silicon carbide	
R. Pampuch, J. Białoskórski and E. Walasek.....	217
Phase equilibria relations in the system Al_2O_3 - SiO_2 - TiO_2 -iron oxide in air	
A. Caballero and S. De Aza.....	229
Phase diagrams of the systems Mn-Ni-O and Mn-Cr-O in air	
Yu.V. Golikov, S.Ya. Tubin, D.V. Bamburov and V.F. Balakirev.....	237
Solubility of iron, chromium and titanium oxides in ZrO_2 based solid solutions	
Ju.N. Karavaev, S.F. Palguez and A.D. Neujmin.....	247
The spinel region of the system Cu-Mn-Cr-O	
I.N. Dubrovina, A.V. Antonov, E.G. Kostitsyn and V.F. Balakirev.....	253
Homogeneous quaternary phases of cubic spinels in the CuO - CoO - NiO - Mn_3O_4 system	
A. Barbulescu and S. Jinga.....	261
Phase relationships in the system SiO_2 - Y_2O_3 - Al_2O_3	
C. O'Meara, G.L. Dunlop and R. Pompe.....	265
The stability of low-temperature metastable cubic and tetragonal phases of zirconia	
Su-Il Pyun, Hyung-Jin Jung and Goo-Dae Kim.....	271
Humidity dependence of phase transformation from tetragonal to monoclinic structure in yttria-doped tetragonal zirconia	
T. Sato, S. Ohtaki, T. Endo and M. Shimada.....	281
Manipulation of displacive phase transformations	
M.V. Nevitt, S.-K. Chan and A.T. Aldred.....	289

Defect and transport properties of manganous sulphide M. Danielewski and S. Mrowec.....	299
Near surface diffusion of oxygen and surface layer thickness in α -alumina Y. Ikuma, W. Komatsu and T. Yamashita.....	309
The thermodynamic factors for the cation diffusion in pure and doped p-type oxides F. Viani, F. Gesmundo and V. Buscaglia.....	319
On the defect chemistry of the silicon sublattice in orthosilicates with olivine structure at high temperatures K. Andersson, G. Borchardt, O. Muller and G. Róg.....	329
Mobility of metal vacancies and chemical diffusion in NiO F. Gesmundo, V. Buscaglia and F. Viani.....	341
Defect chemistry of ceramics through computer simulations A.N. Cormack.....	351
High temperature crystal chemistry of a low thermal expansion material: K-substituted cordierite J.P. Mercurio, D. Mercurio, B. Frit, Y.H. Kim and G. Roult.....	361
Microstructure-kinetics relationship in the thermal decomposition of alkali earth carbonates G. Spinolo and U. Anselmi Tamburini.....	367
Effect of CaCl_2 on the decomposition kinetic of CaCO_3 J. Zborowski, P. Reijnen and D. von Mallinckrodt..... ³	375
Thermal decomposition of (cerium, gadolinium)- and (cerium, europium)- carbonates: compositional and structural changes, and kinetics J.J. Bentzen, P.L. Husum and O. Toft Sørensen.....	385
Mechanisms of interaction of carbon dioxide and isopropyl alcohol with MgO surface E. Longo, J.A. Varela, P.A. Marinho and V.C. Pandolfelli.....	399
Interaction between Ti or Ni and Al_2O_3 or Y_2O_3 S.K. Choi, L. Froyen and M.J. Bräbbers.....	407
Wettability of sintered aluminium nitride by liquid aluminium and indium R. Sangiorgi, M.L. Muolo and A. Passerone.....	415
Crystallization of lithium magnesium zinc silicates S.M. Salman and S.N. Salama.....	429

A2. Process Science

A2.1 Powder Preparation

Colloid science in ceramic powders preparation E. Matijević.....	441
Recent production methods of ultrafine ceramics powders A. Kato.....	459
Preparation via chemical routes of ceramic powders having controlled characteristics L. Marini, L. Balducci, F. Montino and G. Spoto.....	471
On the pseudomorphism in the wet-chemical process of oxide powder preparation T. Reetz and I. Haase.....	481
The use of an organometallic route for the synthesis of barium titanate and yttrium tetragonal zirconia H. Salze, B. Cales and D. Odier.....	491
Synthesis of an easily sinterable B-SiC powder N. Murakawa, M. Nakajima, K. Maruyama, K. Isogaya and K. Yoshida.....	501
Preparation of SiCl_4 from rice hulls T. Okutani and Y. Nakata.....	511
Synthesis of silicon nitride powder by carbothermal nitriding of silica V. Figusch and T. Ličko.....	517
Carbothermal preparation of Si_3N_4 powder M. Bolech, R. Metselaar, F.K. van Dijen, F. Blomer, G. de With and P.P.J. Ramaekers.....	527
Preparation of Si_3N_4 based sintered bodies from powders made by nitridation of amorphous silica in ammonia J. Sjöberg, K. Rundgren, R. Pompe and B. Larsson.....	535
Laser synthesis of ultrafine powders M. Cauchetier, O. Croix, M. Luce, M. Michon, J. Paris and S. Tistchenko.....	545
A2.2 Forming Methods (Bulk Materials/Thin/Thick Films)	
The compounding and injection moulding of ceramics M.J. Edirisinghe and J.R.G. Evans.....	557

Use of organometallic polymer for making ceramic parts by plastic forming techniques	
B.C. Mutsuddy.....	571
Binder removal from injection-moulded ceramic bodies	
R. Gilissen and A. Smolders.....	591
Effects of organic binders on the compaction performance of spray-dried granulates	
C. Hahn and A. Müller-Zell.....	595
Compaction of powders. IV. Binary mixture of thoria and molybdenum disulfide	
I. Shapiro.....	601
Semi-hot consolidation technique applied to Al_2O_3 and Cr_2O_3 -base composites	
F. Nadachowski, E. Drygalska, A. Osiniak, M. Pilch and T. Rymon-Lipiński.....	609
Steric stabilization of silicon carbide slips	
M. Persson, A. Forsgren, E. Carlstrom, L. Kall, B. Kronberg, R. Pompe and R. Carlsson.....	623
Al_2O_3 - ZrO_2 layer composites	
J.L. Besson, P. Boch and T. Chartier.....	633
Studies of ion plated metal/ceramic interfaces	
P.A. Scott, R.K. Knipe, M. Shah and J.M. Rigsbee.....	643
TiO ₂ thin films fabricated by means of rf reactive sputtering using a triode source	
T. Yamashita, J.W. Robinson and H. Yamauchi.....	649
Thin films rf sputtered from $Ba_{2-x}Si_{2-x}TiO_8$ ceramic targets	
R.J. White, M. Ayukawa, G. Demaggio, J.W. Robinson and H. Yamauchi.....	657
Rapid growth of AlN films by particle precipitation aided chemical vapor deposition	
H. Komiyama, T. Osawa, H. Kazi and T. Konno.....	667
Electron assisted CVD process	
M. Wronikowski and A. Sokołowska.....	677
Pilot plant production of lightweight glass-ceramic armour	
R.W. Jones and R. Todhunter.....	685

XIV

A2.3 Gel Processing / Polymer Processing

Gel Technology in ceramics K.S. Mazdiasni.....	693
Freeze-dried ceramics from alcoholic solutions K.R. Reszka and J. Reszka.....	707
Low-temperature sintering through sol-gel routes O. Bouquin, N. Blanchard and Ph. Colomban.....	717
Synthesis of fluorine doped silica and its defluorination behaviour at high temperature M. Shinmei, T. Tsukada, S. Okamoto and T. Yokokawa.....	727
Development of new continuous Si-Ti-C-O fiber with high mechanical strength and heat-resistance T. Yamamura, T. Hurushima, M. Kimoto, T. Ishikawa, M. Shibuya and T. Iwai.....	737
Silicon nitride fibers and silicon oxynitride fibers obtained by the nitridation of polycarbosilane K. Okamura, M. Sato and Y. Hasegawa.....	747

A2.4 Solid State-Liquid Phase-Pressure Sintering / Dynamic Compaction / Hot Forging / Joining / Ion Implantation / Composites

Additives and the sintering of ceramics R.J. Brook.....	757
Fibre reinforced ceramics R.W. Davidge.....	763
Ion implantation and (mono)layer techniques for modifying ceramic surfaces A.J. Burggraaf, P.J. Gelling and D. Scholten.....	779
Hot isostatic pressing and its applicability to silicon carbide and boron carbide H.T. Larker, L. Hermansson and J. Adlerborn.....	795
Joining of ceramics with reference to high temperature applications H.W. Hennicke.....	805
Advances in plasma sintering of alumina D. Lynn Johnson, W.B. Sanderson, J.M. Knowlton, E.L. Kemer and Ming-Yung Chen.....	815

Driving forces and kinetics of diffusional processes during sintering Y.V. Korniyushin and S.P. Oshkadyorov.....	821
Correlation between crystallite size/lattice strain and sintering behavior of commercial alumina powders C. Brodhag, R.A.L. Drew and L. Zarnon.....	829
Sintering and strengthening of cordierite with different amounts of zirconia K. Nieszery, K.-L. Weißkopf, G. Petzow and W. Pannhorst.....	841
Preparation of zirconia-mullite ceramics by reaction-sintering P. Boch and J.P. Giry.....	851
Zirconia-mullite-alumina composites obtained by reaction sintering in the presence of calcium oxide P. Pena, M.A. Rodriguez, J.S. Moya and S. De Aza.....	861
Liquid phase sintering of inactive alumina in the presence of non- oxide additives S. Boskovic and E. Kostic.....	871
Oxide additives for densification of inactive Al_2O_3 powder E. Kostic and S. Boskovic.....	883
Pore stability during the sintering of TiO_2 A.O. Boschi, E. Gilbert, W.E. Worral and R.J. Brook.....	893
Sintering of non-oxide ceramics K. Mitchell and A. Hendry.....	901
Sinterability of silicon nitride powders A. Kato, K. Sarugaku and S. Sameshima.....	911
Heat-treatment of sintered silicon nitride K. Takatori, S. Kobayashi, S. Wada, O. Kamigaito.....	925
Formation of α' -sialons with neodymium and samarium modifying cations S. Hampshire, K.P.J. O'Reilly, M. Leigh and M. Redington.....	933
Kinetics of sintering of silicon nitride with mixed oxide additives S. Hampshire, M.J. Pomeroy and B. Saruhan.....	941
Sintering of Si_3N_4 with liquids in the system $MgO-AlN-SiO_2$ P.K. Das and J. Mukerji.....	953
Mechanisms in the liquid phase sintering of boron carbide with silicon based melts R. Telle and G. Petzow.....	961

Pressureless sintering of aluminum nitride A. Kranzmann, P. Greil and G. Petzow.....	975
Sintering of Si_3N_4 powder compacts under high nitrogen pressure G. Wotting and G. Ziegler.....	983
Post-sintering of reaction-bonded silicon nitride under high nitrogen pressure H.-J. Kleebe, G. Wotting and G. Ziegler.....	993
Hot-pressing of SiC powder at 1600 to 1800 °C T. Iseki, T. Yano, M. Imai and B.W. Lin.....	1003
Sintering and hipping of silicon nitride - silicon carbide composite materials P. Greil, H. Tanaka and G. Petzow.....	1011
Fabrication of dense Si_3N_4 by hot isostatic pressing H. Okada, K. Homma, T. Fujikawa and T. Kanda.....	1023
Solid-state bonding of silicon nitride to metals using HIP M. Koizumi, M. Takagi, K. Suganuma, Y. Miyamoto and T. Okamoto.....	1033
Examples of superplastic forming fine-grained Al_2O_3 and ZrO_2 ceramics C. Carry and A. Mocellin.....	1043
Solid-state bonding of copper to alumina M. Courbiere, D. Juve, D. Treheux, C. Beraud, C. Esnouf and G. Fantozzi.....	1053

A3. Materials Characterization and Testing Methods

A3.1 Microstructure

The characterisation of engineering ceramics using molecular spectroscopy G.L. Marshall.....	1065
Analytical electron microscopy of ion beam modified $\alpha\text{-Al}_2\text{O}_3$ P.S. Sklad, C.J. McHargue, C.W. White and G.C. Farlow.....	1073
Carbon paste electrode: a simple and non expensive tool for morphological study of powdered iron oxides F. Chassagneux, B. Durand and O. Vittori.....	1083
Use of EPR for the evaluation of interactions in ceramic systems V.I. Trefilov, L.T. Akulova, M.V. Vlasova, N.G. Kakazey, V.N. Minakov and M.D. Smolin.....	1091

Microstructure of pressureless sintered silicon carbide with additions of aluminium oxide	
M. Sasaki, K. Suzuki, H. Nishimura and M. Noshiro.....	1101
Evolution of the zirconium phases in yttria TZP	
C. Leach and P. Taney.....	1109
Structure and properties of ceramic fibers prepared from polymeric precursors	
J. Lipowitz, H.A. Freeman, H.A. Goldberg, R.T. Chen and E.R. Prack....	1119
Advanced measuring facilities for testing traditional and new ceramic materials	
W.-D. Emmerich and E. Kaisersberger.....	1129
A3.2 Corrosion	
The corrosion behaviour of silicon nitride - A limiting factor to expectations?	
P.K. Datta, K.N. Strafford, J.S. Gray and C. Gill.....	1137
Oxidation behaviour and high temperature strength of hot-pressed SiC with various sintering aids	
Jiang Dongliang, Kuang Gao, Pan Zhensu, Tan Shouhong, Mao Jieying and Ke Shumin.....	1149
A3.3 Mechanical Properties	
Tensile testing of ceramic materials - A new approach	
L. Hermansson, J. Adlerborn and M. Burström.....	1161
Computer-aided nondestructive ultrasonic testing of ceramic materials	
A. Hecht, E. Neumann and P. Rose.....	1169
Models of destruction of ceramics at high-speed deformation	
V.B. Lazarev, V.Ya. Shevchenko, A.D. Isotov and V.I. Lebedev.....	1179
The degradation of tensile strength of ceramics from prior compression	
G. Sines and T. Taira.....	1187
Relation between microstructure and Weibull distribution function of coarse grained ceramics	
F.E. Buresch and W. Meyer.....	1197