Advanced Ceramics. Ramakrishnan, P. ed. Oxford and IBH Publishing Co., Pvt. Ltd., 66, Janpath, New Delhi 110 001. 1992. 252 pp.

The book, an edited version of the papers presented at the National Conference on Advanced Ceramics held at IIT, Bombay during March 8–9, 1990, serves to present a selective cross-sectional flavour of work being attempted in the country in the area of advanced ceramic materials. The book has been organized into seven sections dealing with an Introduction, Raw Materials for Advanced Ceramics, Structural Ceramics, Electrical and Electronic Ceramics, Cutting Tool, Abrasion Resistant and Machinable Ceramics, Ceramic Coating and a Panel Discussion Report on the exploitation of the indigenous capabilities and potential for production and utilization of advanced ceramic materials in the country.

In the introductory chapter the editor presents a very brief perspective of the various general methods of preparation of advanced ceramic materials, their forming or shaping, and their sintering as well as their present day applications and potential for future use. The next paper by Page, Borkar and Chatterjee briefly presents the source requirements for development of suitable raw materials of advanced ceramics and the various processes which could be exploited to use the indigenously available resources. A good reference is made to exploitation of the alumina and zirconia available in abundance in the country.

The section on Structural Ceramics containing nine articles is distributed amongst zirconia ceramics (3), reaction sintered silicon nitride (1), nuclear ceramics, ThO_2 and UO_2 (1), alumina (1) and design criteria for utilization of advanced ceramics in various potential applications (1). The paper on defect zirconia system deals with mechanical and electrical energy dissipation mechanisms in doped ZrO_2 systems. Point defects directly affect the mechanical and electrolytic performance of these ceramics. A paper on the growth of thin zirconia films on sapphire substrates describes the development of thin sintered but porous films of cubic and monoclinic zirconia (≤ 150 nm thick) made by dip coating the substrate into a zirconia salt solution and heating respectively to 450 and 900° C. The films show texture (002 reflection) indicating the preference of the (002) growth direction on alumina substrates. Another paper on zirconia deals with the sintering of partially stabilized zirconia ceramics (CeO_2, MgO, Y_2O_3 doped) derived through an inorganic sol-gel route. Sintering of the calcined powders (0.6–0.8 μm) at 1600° C is reported to yield 95% dense bodies. Another paper on 12 mole% ceria stabilized zirconia records a fracture toughness of 16 MPa $\sqrt{m}$. In an interesting paper on the sintering of high temperature oxide materials like ThO_2 and UO_2 derived from their respective chemically prepared precursors containing MgO, Nb_2O_5, Y_2O_3 and Gd_2O_3 as sintering aids, factors that lead to low sintered densities have been examined. Too low or too high a calcination temperature, too high a precompaction pressure (resulting in packing inefficiencies or agglomeration of major powders) as well as the agglomerated nature of minor constituents (which could leave large voids on dissolution into major constituent in the course of sintering) are indicated as important contributing factors towards the non attainment of good sintered densities. Preparation of fine powders of narrow size distribution, deagglomeration and homogenization of powders before compaction are some of the preventive methods which could be employed. The conclusions drawn are also applicable to processing of other ceramic materials in general. In an introductory paper on sintering of alumina (at 1575° C in flowing nitrogen gas for 1 h) in a graphite furnace followed by heat treatment in air at 1200° C for varying periods up to 8 h, a 20% increase in modulus of rupture and a 60% increase in fracture toughness have been observed attributable to the formation of small amounts of aluminiumoxycarbides at the grain boundaries. Reaction sintering under nitrogen is an inexpensive fabrication route to obtain near net shape silicon nitride bodies. In an effort to study the effect of silicon nitride as a major and as a minor additive to silicon, milled and compacted Si_3N_4 and Si powder mixtures in the ratios 90:10, 80:20, 60:40 and 0:100 respectively were nitrided between 1200 and 1400° C and resultant sintered bodies were investigated for extent of nitride formation, porosity evolution and microstructure. The reaction and sintering behaviour of silicon and (60 Si_3N_4 + 40 Si) mixture were found to be similar, owing to the continuity available due to interpenetrability of the two phases in the latter case.

The section on Electronic Ceramics consists of six papers: superconducting Ag–YBC (123) system (1), Barium titanate systems (2), Cobalt ferrite for electromagnetic radiation absorption (1), alumina and alkaline earth sulphides for luminescence and energy storage properties (1) and electrical conductivity of $ZrO_2 + 10Y_2O_3$ containing 1–5 wt% bismuth oxide as sintering aid (1). The study of the system xAg $(1-x)$ 123 YBC (where $x=5$ and 10–90 wt% Ag) indicates retained superconductivity at 95 K and the added advantage of easy malleability of the (123) superconductor for values of x beyond 60. In addition the composition with $x=60$ also displays an enhanced T_c of 100 K due possibly to the availability of a conduction electron pathway for attractive interactions which would increase T_c. In the paper on barium titanate system a 0.3 at.% Sb doping of $BaTiO_3$ sets up strongly insulating barrier layer at the grain boundaries which are diagnosed by high dielectric constant (10^5) and high loss tangent ($\tan \delta > 0.5$) properties and also confirmed by SEM studies. Long soaking periods (beyond 20 h) increase the thickness of the barrier layer (without any grain growth) to such an extent that transition from PTCR behaviour to that of a barrier layer capacitor results. The performance of hexagonal M type ferrite ($BaCO_{0.92}Ti_{0.92}Fe_{10.16}O_{19}$) as an electromagnetic radiation absorber in radio frequency and microwave bands has been measured after coating (to 70% fill factor) a pigment containing the ferrite on alumina and carbon fibre-based substrates. A theoretical model based on a T-matrix formulation has been developed to explain the behaviour which is a complex function of particle size and shape and of the composition of the ferrite powder, its fill factor, thickness of coating and frequency of absorption. Paper on luminescence and energy storage properties of alumina and alkaline earth sulphide materials presents the thermally stimulated luminescence (TSL) data on alumina doped with V, C, Ti and on alkaline earth phosphors like CaS, BaS and SrS doped with Bi, Cr and Sm after an excitation with

radiation (like UV, X(35 kV, 10 nA) and γ-(CO^{60})-rays) and heating at a rate of 20°/min up to 500° C. The glow peaks in general increase with irradiation time in all cases. The observed behaviour is influenced by both the intrinsic defects like traps present in the lattice as well as by the doped impurities or both. The last paper in this section deals with the use of 3 mol% Bi_2O_3 as a liquid phase sintering aid to obtain high density (>95% TD), zero open-porosity ZrO_2–10 mol% Y_2O_3 conducting bodies (at 1375 K) which find application as solid electrolyte oxygen sensors. The advantage of this sintering aid is that it is a good oxide ion conductor (having negligible electronic conduction) with a low melting point (1125 K) so that it effects the sintering at this low temperature and could be evaporated off after densification leaving behind only traces of Bi(III) oxide which does not affect the electrical conduction behaviour of the zirconia–yttria system.

The section on Cutting Tool, Abrasion Resistant and Machinable Ceramics has four papers. The first one presents the results of a comparative study of alumina, sialon and tungsten carbide tools for machining grey cast iron. The results presented are broadly comparable. At machining speeds of 200 m/min, maximum tool life was achieved for sialon tools (13 min); at 140 m/min, it was alumina which performed better (15 min); while it was 10 min for WC tool-bit for the same speed (140 m/min). The tool life exponent for the materials were 0.89, 0.74 and 0.52 respectively for sialon, alumina and WC. A succeeding paper presents the wear behaviour of alumina ceramic cutting tools in the machining of mild steel and cast iron work pieces. While the main wear was found to be flank wear due to abrasion, crater wear due to spalling and catastrophic failure due to brittleness of the tool and the nonrigidity of the machine/tool are also occasional. These tools exhibit a higher resistance to wear compared to WC tools at higher cutting speeds owing to the retention of hardness and compressive strengths of the former at higher temperatures. A paper on ceramic and thermal processing of alumina powders for developing abrasion-resistant high alumina ceramic materials for use as mill-liners and as grinding media has been included, keeping in view, the effect of grain size and pore size on the microstructure and thereby on the mechanical strengths and abrasion resistance. To have homogeneous distribution of small pores, the optimized condition of powder processing as well as the sintering conditions (1500–1550° C) of the formed body are important. The last paper in this section describes the development of a machinable glass ceramic (flour-mica) in the system K_2O-SiO_2-MgO-Al_2O_3-F through a melt and gelation route. It has properties comparable with commercial 'Macor'.

The section on Ceramic Coatings contains three articles, two devoted to plasma-sprayed coatings and one to thermal-rod sprayed coatings. Plasma spraying of zirconia powders on various metallic substrates is reviewed in the paper by Mustaq Babi in regard to the salient features of the plasma flame and its augmentation and manipulation by a control of various contributive parameters. The application areas of these coatings are indicated. A more general paper on plasma spraying of ceramic powders by Elayaperumal describes the use of a 'plasmadyne' gun to obtain plasma coats of various materials like alumina, chromia, titania, carbides, etc. and the scope for application of these coatings on a variety of components whose wear, corrosion and high temperature resistance would be enhanced by these coatings. The last paper in this section deals with the use of the technique of oxyacetylene flame spraying of ceramic coatings using sintered ceramic rods as the source of ceramic spray. The paper deals with the use of Norton's high velocity (200 m/s) Rokide oxyacetylene flame gun to obtain highly consistent coatings of alumina, chromia, alumina–titania, partially stabilized zirconia, etc. to obtain high wear and corrosion resistant as well as electrically and thermally insulating coatings of industrial importance.

The last section of the book presents a report on the panel discussion organized during the conference on the prospects of the use of advanced ceramics in the Indian industry. Specialists from industry, academic institutions and R&D labs participating in the discussion stressed the need to develop both R&D bases (in the academic institutions and R&D labs) and production capability bases (in the industries) with a substantial interfacing and interaction between them to promote the advanced ceramics activity in the country.

The book on the whole provides an interesting survey of the behaviour of several advanced ceramic materials which have become important in recent times and their utilization and provides a window for highlighting of some of the current activities in the country in the area of advanced ceramics.

T. S. KANNAN
P. S. GOPALAKRISHNAN

Materials Science Division
National Aeronautical Laboratory
Post Bag No. 1779
Bangalore 560 017, India

Industrial Biotechnology. V. S. Malik and P. Sridhar eds. Oxford and IBH Publishing Co., Pvt. Ltd., 66, Janpath, New Delhi 110 001. 1992. 621 pp. Price: Rs 695.

The presentations during an International Symposium on Industrial Biotechnology have been presented in a book form by Malik and Sridhar. There are seven chapters in the book dealing with general introduction and trends, industrial strain improvement, molecular biology of industrial organisms, engineering of industrial organisms, industrial enzymes and biocatalysts, fermentation technology, biotransformation and biodegradation, and miscellaneous antibiotics.

Ramachandran's introductory presentation gives an excellent bird's-eye view of this subject. This is followed by three very informative articles by Gorman, Malik and Lillehaj, and Ghosh.

Presenting a chemist's point of view, Gorman narrates the shifting patterns of disease, a shift in the cures from secondary to primary metabolites and novel classes of drugs made possible by biotechnology. The spread of these classes beyond the realm of drugs into diagnostics, agriculture, environment and bulk chemical production is also narrated. He has also drawn attention to the exciting possibilities of biotechnology-based drugs and the mammoth projection of potential markets.

Malik and Lillehoj have briefly des-