CONTENTS

Preface Symbols and Abbreviations		v xi
1	Overview: Porosity (and Microcrack) Dependence of Properties	. 1
1.1 1.2 1.3 1.4 1.5 1.6	Introduction Understanding the Microstructural Dependence of Properties Sources and Occurrences of Porosity and Microcracks Measurement of Properties to Be Evaluated Key Aspects of the Porosity Dependence of Properties Summary References	1 3 10 23 35 37 38
2	Evaluation of the Porosity Dependence of Properties	43
2.1 2.2 2.3 2.4 2.5 2.6 2.7	Hierarchy of Porosity Impacts on Properties Idealized Pores and Microcracks and Modeling Parameters Porosity and Microcrack Characterization Modeling of Porosity and Microcrack Effects on Physical Properties Comparisons of MSA and Mechanistic Models Data Evaluation Needs and Self-Consistency Summary References	43 47 57 62 91 92 93 95
		vii

viii		Contents	Conte	ents	ix
3	Porosity and Microcrack Dependence of Elastic Properties at Low to Moderate Temperatures	100	7	The Porosity and Microcrack Dependence of Thermal and Electrical Conductivities and Other	245
3.1	Porosity Dependence Background	100		Nonmechanical Properties	315
3.2	Models	102	7.1	Introduction	315
3.3	Comparison of Models and Data	120	7.2	Models and Other Theoretical Considerations	316
3.4	Self-Consistency Tests and Refinement of Models	146	7.3	Comparison of Models and Data	340
3.5	Data Quality	150	7.4	Discussion	363
3.6	The Need for More Comprehensive Studies	154	7.5	Summary	366
3.7	Summary	156		References	368
5.7	References	159			
4	Porosity and Microcrack Dependence of Fracture Energy and Toughness and Related Crack Propagation at 22°C	168	8	Porosity and Microcrack Dependence of Mechanical Properties of Ceramic Composites, Other Ceramics, and Other Materials at 22°C	375
			8.1	Introduction	375
4.1	Introduction	168	8.2	Theoretical Considerations and Models	377
4.2	Concepts and Models	169	8.3	Evaluation of Data and Comparison with Models	386
4.3	Comparison of Data and Theoretical Expectations	182	8.4	Discussion and Summary	418
4.4	General Discussion	198		References	421
4.5	Summary	203			
_	References	205	9	Porosity and Microcrack Effects on Thermal Stress and Shock Fracture and Properties	
5	Porosity Effects on Tensile Strength (and Reliability)	240		at Elevated Temperatures	429
	at Low to Moderate Temperatures	210	9.1	Introduction	429
5.1	Introduction	210	9.1	Models and Concepts	430
5.2	Models for Porosity (and Microcrack) Dependence	211	9.2	Comparison of Models, Theoretical Expectations,	
5.3	Data and Model Comparison (Low to Intermediate P at 22°C)	219	9.3	and Observations	437
5.4	Discussion	261	9.4	Discussion	467
5.5	Summary	267	9.5	Summary	469
	References	269	9.3	References	469
6	Porosity Dependence of Hardness, Compressive Strength, Wear, and Related Behavior at 22°C	276	10	Summary of Porosity and Microcracking Effects, Applications, Special Fabrication, and Engineering	475
6.1	Introduction	276	10.1	Introduction	475
6.2	Theoretical Aspects	277	10.2		
6.3	Comparison of Models and Data	285	10.2	and Related Materials	477
6.4	Discussion	307	10.3		495
6.5	Summary	309		Fabrication and Processing	504
0.0	References	310		Discussion and Conclusions	518
				References	526
			Inde	ex	
			2000 Aug.		533