

Table of Contents

Introduction.....	4
1. Literature review	6
1.1 Transport mechanisms	6
1.2 Perovskites and K_2NiF_4 structured material	7
1.2.1 $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-\delta}$ (BSCF)	9
1.2.2 $La_{0.58}Sr_{0.4}Co_{0.8}Fe_{0.2}O_{3-\delta}$ (LSCF)	10
1.2.3 Oxygen permeation flux data for perovskites	12
1.2.4 $La_2NiO_{4+\delta}$ (LNO)	13
1.2.5 Oxygen permeation of BSCF, LSCF and LNO	15
1.3 Thermal and chemical expansion	16
1.4 Spin transition	22
1.5 Fracture stress, fracture toughness and Young's modulus	22
1.6 Creep	30
2. Experiments.....	34
2.1 BSCF and LSCF perovskites	34
2.1.1 Ring-on-ring tests	35
2.1.2 Micro-indentation	36
2.1.3 X-ray diffraction.....	39
2.1.4 Thermal property characterization	40
2.1.5 Transmission electron microscopy	40
2.1.6 Creep tests.....	40
2.2 Experiments with $La_2NiO_{4+\delta}$ (LNO).....	41
2.2.1 Four point bending tests	42
2.2.2 Complementary characterizations	43
3. Results and discussion.....	44
3.1 BSCF	44
3.1.1 Young's modulus and fracture stress	44

3.1.2 Indentation results	47
3.1.3 Comparison of Young's modulus, fracture stress and fracture toughness	55
3.1.4 Fracture surfaces	57
3.1.5 Discussion of possible mechanisms governing the mechanical anomaly	59
3.1.5.1 Structural characterization with XRD	60
3.1.5.2 Phase stability at high temperatures	61
3.1.5.3 Association and dissociation of defects	65
3.1.5.4 Spin transition	66
3.1.5.5 Thermal and chemical expansion.....	68
3.2 LSCF	70
3.2.1 Non-linearity of load-displacement.....	70
3.2.2 Young's modulus	72
3.2.2.1 Young's modulus in air	72
3.2.2.2 Young's modulus under vacuum (10^{-5} mbar)	73
3.2.3 Phase compositions of LSCF	75
3.2.4 DTA/TG	77
3.2.5 Thermal and chemical expansion.....	79
3.2.6 Domain structure of LSCF	80
3.2.7 Fracture stress.....	84
3.2.8 Indentation	86
3.2.8.1 Temperature dependence.....	86
3.2.8.2 Cooling rate dependence	87
3.2.9 Magnetic susceptibility.....	90
3.2.10 Residual stresses	90
3.2.11 Fracture surface.....	91
3.2.12 Creep	94
3.3 LNO	99
3.3.1 Stiffness of LNO	99

3.3.2 Fracture stress	101
3.3.3 TG/DTA	102
4. Conclusions.....	104
4.1 BSCF	104
4.2 LSCF	105
4.3 LNO	106
4.4 Comparison of BSCF, LSCF and LNO	106
References.....	110
List of Figures.....	121
List of Tables	125
Nomenclature.....	126
Acknowledgements	129
List of publications.....	130