Content

1	Intr	oduction	1
	1.1	Economic and ecologic demand for electricity	1
	1.2	Aims of SOFC research and development	1
	1.3	Objectives of this work and outline	
2	Fun	damentals and background	
	2.1	Fuel cells	
	2.1.1		4
	2.1.2	Operation principle of SOFC	6
	2.1.3	Thermodynamics	7
	2.1.4	,	8
	2.1.5	Electrolytes	11
	2.1.6	Anodes	14
	2.1.7	Cathodes	14
	2.1.8	Cell design	15
	2.2	Sol-gel processing	17
	2.2.1		18
	2.2.2	Polymene and conoidal sois	20
	2.2.3	Spin-coating	22
	2.2.4	Dip-coating	23
	2.2.5		25
3	Exp	erimental	27
	3.1	Electrolyte preparation strategies	27
	3.2	Synthesis and sample preparations	27
	3.2.1	A two-step polymeric zirconia sol-gel process	27
	3.2.2		28
	3.2.3	Preparation of commercial colloidal zirconia and ceria nano-suspension	29
	3.2.4	Synthesis of CGO, LSM and LSFC polymeric sols from inorganic metal salts	29
	3.2.5		30
	3.2.6	Preparation of substrate and anode	30
	3.2.7		
	3.2.8		$\frac{32}{32}$
	3.2.9	•	32
		Characterizations	32
	3.3.1 3.3.2	A december	22
	3.3.3		
	3.3.4	Dilatometry	33
	3.3.5		
	3.3.6		
	3.3.7	CEM and TEM	2.4
	3.3.8		
	3.3.9	Electrochemical single cell test	37
4	Resi	ults and discussion	38
	4.1	Fundamental characterization of materials	38
	4.1.1	YSZ polymeric sols and derived powders	
	4.1.2		45
	4.1.3		47

Content

	4.1.4	Nano-suspensions made of commercial oxide particles	51		
	4.1.5	Results of dilatometric measurements	56		
4	1.2	Characterization of layers	58		
	4.2.1	Substrates	58		
	4.2.2	Layers deposited with polymeric sols	60		
	4.2.3	Layers deposited with nano-suspensions	64		
4	l.3 I	Electrochemical characterization of single cells	78		
	4.3.1		SCF		
		e (Group 1-1)	80		
		Single cells with multi-layered electrolyte, CGO layer and sintered LSCF cathode			
	(Group 2-1 and Group 2-2)				
	(Group 2-1 and Group 2-2) 83 4.3.3 Single cells with co-sintered multi-layered electrolyte, CGO layer and LSCF cathode				
	(Group	3-1, Group 3-2 and Group 3-3)	92		
	4.3.4	Electrochemical impedance spectroscopy (EIS)	106		
	4.3.5	Single cells with co-sintered multi-layered electrolyte, CGO layer and LSC cathod	e		
	(Group 4-1)1		112		
	4.3.6	Summary of electrochemical characterizations	118		
5	Summary1		_121		
6	References				
7	Acknowledgements		129		