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New Glass-Ceramic Sealants for SOEC Applications

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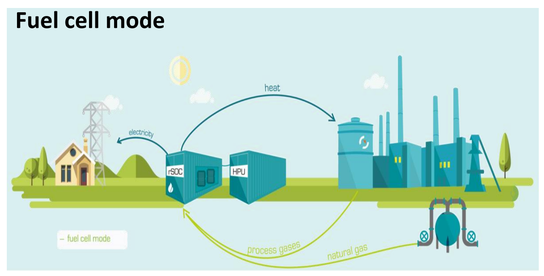
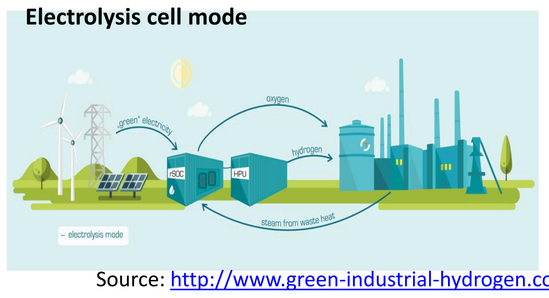
ABSTRACT

New glass-ceramic compositions were designed and characterised as sealant materials for solid oxide electrolysis cell (SOEC) and rSOC applications (working temperature at 850°C). The crystallization and the sintering behaviour were investigated using Differential Thermal Analysis (DTA) and Heating Stage Microscopy (HSM). The thermo-mechanical and thermo-chemical compatibility of the glass-ceramic sealants with 3YSZ and with Crofer22APU substrates was examined. Thermal treatments at 900-950 °C in air were used for joining purposes. $Mn_{1.5}Co_{1.5}O_4$ coating was deposited on flat as well as corrugated Crofer22APU substrates by electrophoretic deposition (EPD). The compatibility between the glass-ceramic sealant and the Crofer22APU is reviewed by means of SEM and EDS.

INTRODUCTION

The GrInHy project (Green Industrial Hydrogen via reversible high-temperature electrolysis) includes designing, manufacturing and operation of a reversible generator based on the Solid Oxide Cell technology in a relevant industrial environment.





Source: http://www.green-industrial-hydrogen.com/home/

Glass sealants used in Stack Development must have:

- Chemical, mechanical and thermal stability
- High electrical resistivity (>10^4 ohm.cm)
- CTE close to other cell components (9-11 *10^{-6} K^{-1})
- Strong bonding to other stack components

OBJECTIVES

- Synthesis, design and characterization of new glass ceramic sealants for SOEC and rSOC
- Development of protective coatings on metallic interconnect for SOEC and rSOC

EXPERIMENTAL

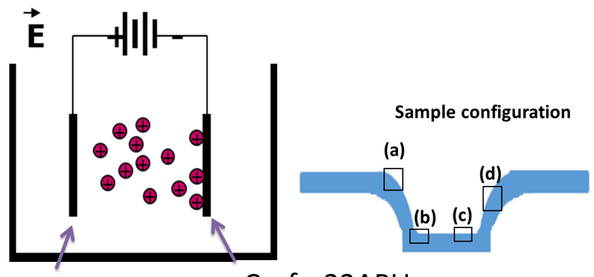
Glass Compositions (mol%)

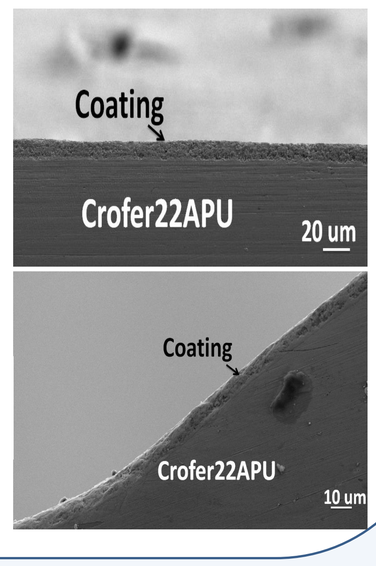
	C1	H1	HJ1	HJ3	HJ3b	HJ4
SiO_2: SrO	3:1	2:1	4:1	5:2	3:2	2:1
Other modifiers	CaO, MgO, La_2O_3	CaO, MgO, La_2O_3	CaO, MgO	CaO, MgO, Y_2O_3	MgO, Y_2O_3	Y_2O_3

Protective Coating by Electrophoretic deposition

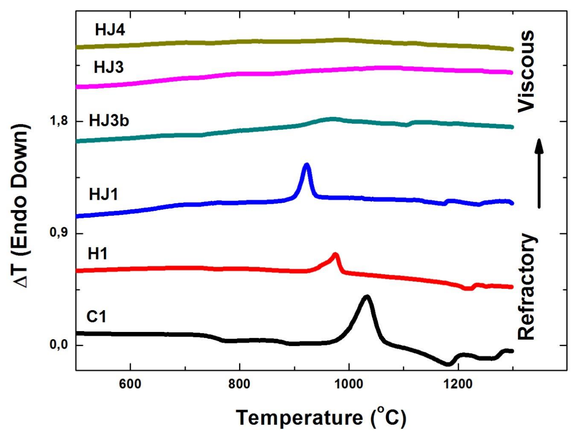
Material: $Mn_{1.5}Co_{1.5}O_4$

Substrate: Crofer22APU

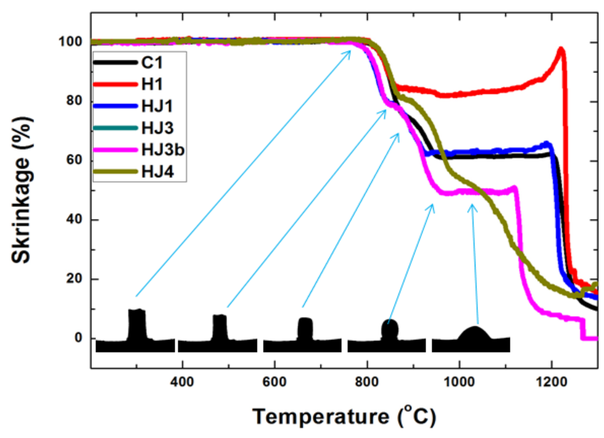




RESULTS AND DISCUSSION

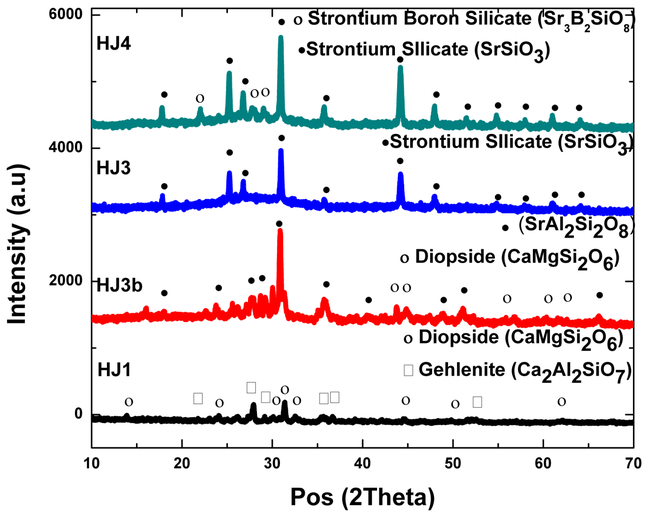


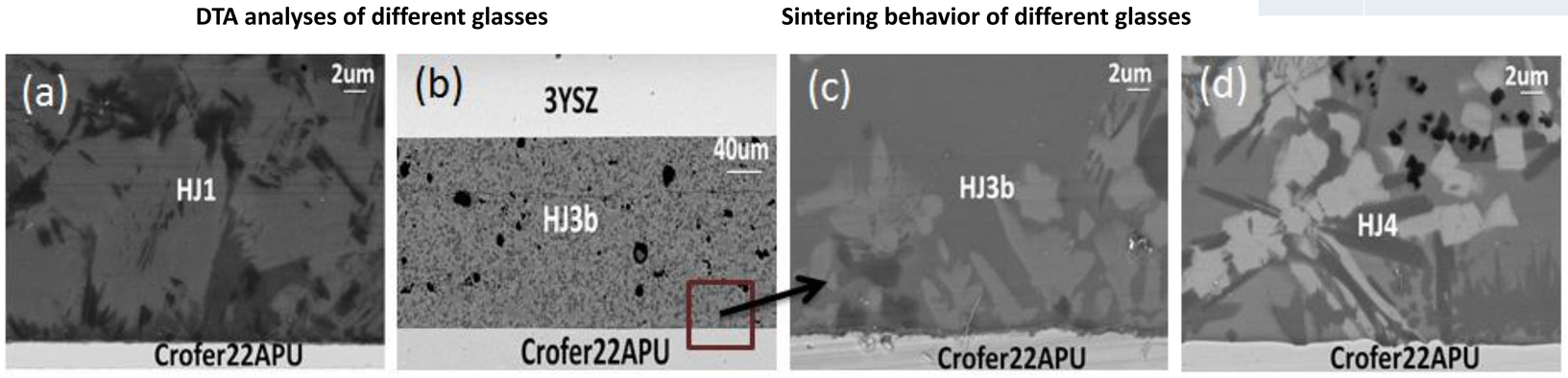
DTA analyses of different glasses

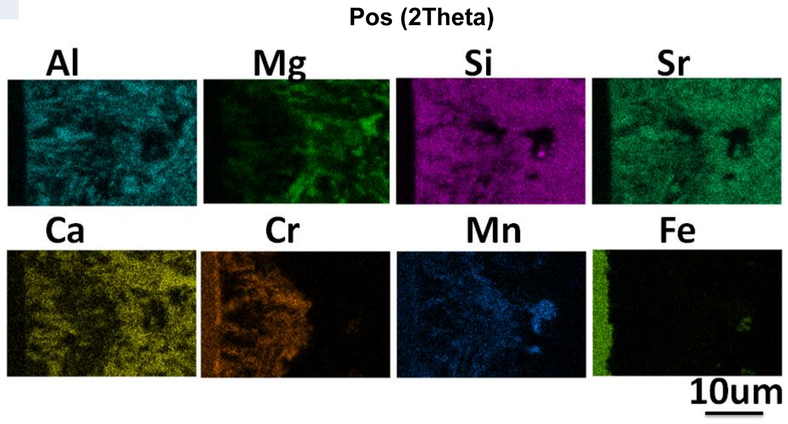


Sintering behavior of different glasses

	CTE ($1*10^{-6}$) K^{-1}
C1	10.5
H1	10.6
HJ1	9.7
HJ3b	10.2
HJ3	8.9
HJ4	9.3







Bonding of (a) Crofer22APU/HJ1 (b) Crofer22APU/HJ3b/3YSZ (c) Crofer22APU/HJ3b and (d) Crofer22APU/HJ4, after joining process

Post mortem analysis of bare Crofer/HJ1 glass ceramic interface after 1000h @850 °C

CONCLUSIONS

C1 and H1 showed poor compatibility due to reaction between Sr and Cr at the Glass/Crofer interface

Viscous sealants showed excellent bonding to Crofer22APU

Glass ceramics showed CTE matching with other cell components

FUTURE ACTIVITIES

Mechanical characterization at RT and high temperature

Joined samples test in dual atmosphere

Electrical resistivity measurement of glasses (on going)

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