Effect of MgO Addition on Crystalline Phase Formation and Thermal Expansion of a Barium Aluminosilicate SOFC Glass-Ceramic Sealant

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MSRI

Objectives :

- Optimize the amount of nano-MgO to be added to the BCAS glass composition.
- Modify the BCAS base-glass composition to accommodate required amounts of nano-MgO.
- Formulate glass-MgO compositions having the desired phases on crystallization.
- Optimize coating processes for doped lanthanum chromite and alumina on metallic interconnects.
- Investigate the thermal, chemical and mechanical stability of glass-MgO sealing compositions over extended durations at 800ºC.

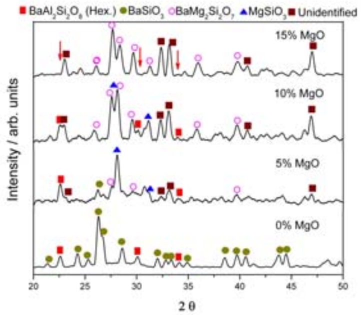

Figure-1

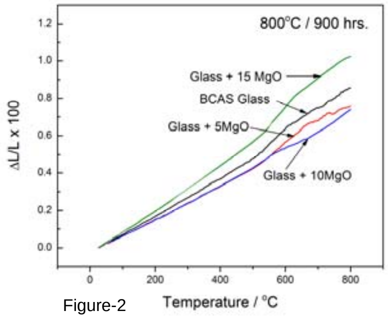

Figure-2

Composition	Coefficient of thermal expansion (25 to 500°C)	
	800°C / 0.5 hr.	800°C / 900 hrs.
BCAS Glass	11.6 x 10^{-6} / °C	10.0 x 10^{-6} / °C
Glass + 5MgO	10.5 x 10^{-6} / °C	9.0 x 10^{-6} / °C
Glass + 10MgO	11.5 x 10^{-6} / °C	9.0 x 10^{-6} / °C
Glass + 15MgO	12.4 x 10^{-6} / °C	12.1 x 10^{-6} / °C

Table-I

Glass-MgO compositions having 0, 5, 10 and 15% nano-MgO by volume were prepared. The compositions were held at 800ºC for 30 minutes. Figure-1 shows the XRD traces of these samples. At 15% MgO, the formation of the deleterious hexacelsian phase was suppressed. The predominant phases for 15% MgO added composition are $BaMg_2Si_2O_7$ and an unidentified phase. Figure-2 shows the thermal expansion traces for the above compositions after holding at 800ºC for 900 hours. As shown in Table-I, the glass composition with15% MgO shows the least change in CTE after 900 hours at 800ºC. This could be attributed to the formation of the two stable crystalline phases.

Two new base glass compositions (3 and 5) were formulated to overcome the high viscosity and poor flowability of BCAS glass with 15% addition of MgO. As shown in Figure-3, the addition of 15% MgO to these compositions results in the formation of the desired crystalline phases on devitrification that are stable after 1000 hours at 800ºC. The thermal expansion traces after 1500 hours at 800ºC are shown in Figure-4 for the new MgO added compositions in comparison to BCAS glass. As shown in Table-II, there is minimal change in CTE for the two new compositions when compared to BCAS glass.

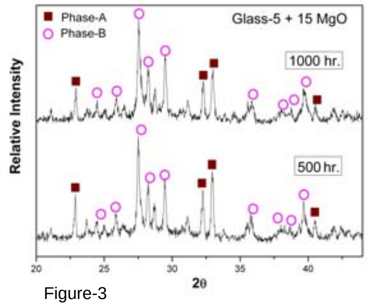

Figure-3

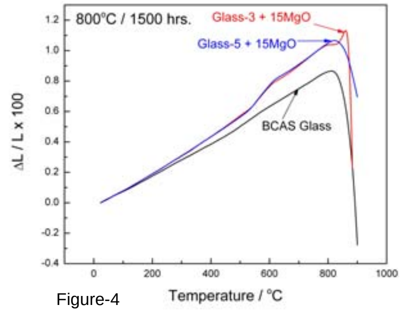

Figure-4

Table-II

Duration	Coefficient of thermal expansion (25-800°C)		
	BCAS Glass	Glass-3 + 15MgO	Glass-5 + MgO
0.5 hr. /800°C	11.6 x 10^{-6} / °C	11.8 x 10^{-6} / °C	11.8 x 10^{-6} / °C
1500 hr./800°C	10.0 x 10^{-6} / °C	12.0 x 10^{-6} / °C	12.0 x 10^{-6} / °C

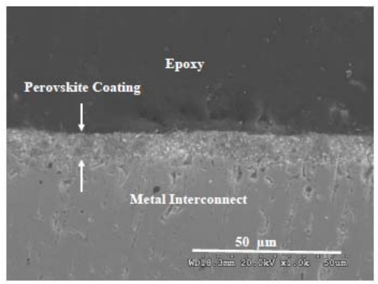

Figure-5

A $LaCrO_3$ based 10 µm perovskite coating was applied by a combination of spray, infiltration and thermal treatment on metallic interconnects.

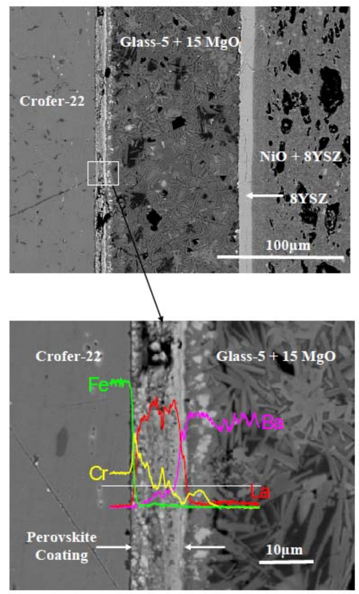

Figure-6

Figure-6 is the SEM micrograph of a 8YSZ / glass-5 +15MgO / coated Crofer-22 foil sandwich configuration held at 800ºC for 500 hours in air. The low and high magnification images show excellent bonding at the 8YSZ glass and glass perovskite interfaces. The EDAX traces show that the coating acts as an effective barrier to chromium migration from the oxide scale surface to the glass.

Conclusions: **The results indicate that glass-MgO compositions 3 and 5 have stable crystalline phases and thermal expansion coefficients over prolonged durations at 800ºC. They form clean and stable seal interfaces with the SOFC electrolyte (8YSZ) and Crofer-22 metal foil coated with doped lanthanum chromite.**