Evaluation of Durable Glass-Magnesium Oxide Sealing Compositions for High Temperature Fuel Cells

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Objectives :

- Formulation of modified base-glass compositions and incorporation of required amount of MgO.
- Completion of long term evaluation of thermal, chemical and mechanical stability of selected compositions.
- Helium leak testing of gaskets fabricated from selected glass-MgO compositions and BCAS glass.
- Performance evaluation of a stack that incorporates select glass-MgO sealing gaskets and coated metallic interconnects.

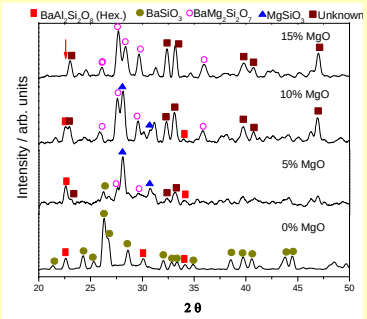

Figure-1

Table-I

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

Glass-MgO compositions having 0, 5, 10 and 15% nano-MgO by volume were prepared. The compositions were held at 800°C 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 As shown in Table-I, the glass composition with15% MgO shows the least change in CTE after 900 hours at 800°C. This could be attributed to the formation of the two stable crystalline phases.

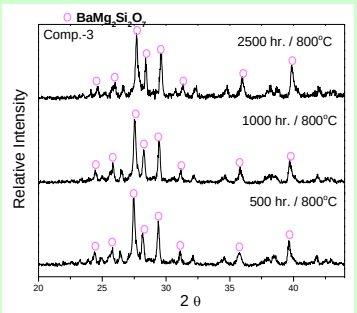

Figure-3

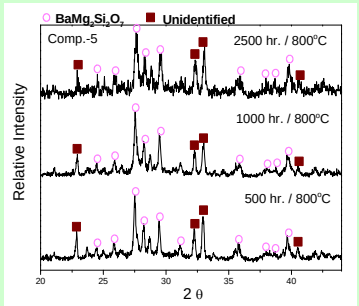

Figure-4

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 and 4, the addition of 15% MgO to these compositions results in the formation of the desired crystalline phases on devitrification that are stable after 2500 hours at 800°C. The thermal expansion traces after 2500 hours at 800°C are shown in Figure-4 for the new MgO added compositions in comparison to BCAS glass. As shown in Table-II, there is less change in CTE for the two new compositions when compared to BCAS glass.

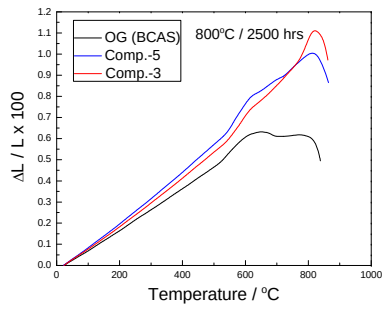

Figure-5

Table-II

Duration at 800°C (Hours)	BCAS Glass	Comp.-3	Comp.-5
0.5	11.6 x 10^{-6}/°C	11.8 x 10^{-6}/°C	11.8 x 10^{-6}/°C
1500	10.0 x 10^{-6}/°C	12.0 x 10^{-6}/°C	12.0 x 10^{-6}/°C
2500	9.8 x 10^{-6}/°C	11.2 x 10^{-6}/°C	12.0 x 10^{-6}/°C

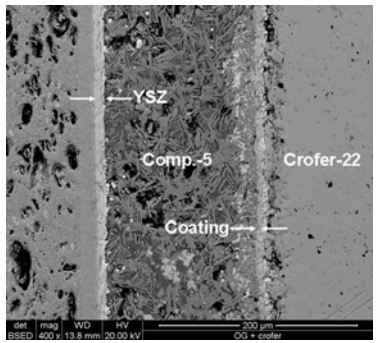

Figure-6: SEM micrograph of 8YSZ-Seal - Coated Crofer-22 sandwich heated at 800°C for 3000 hours.

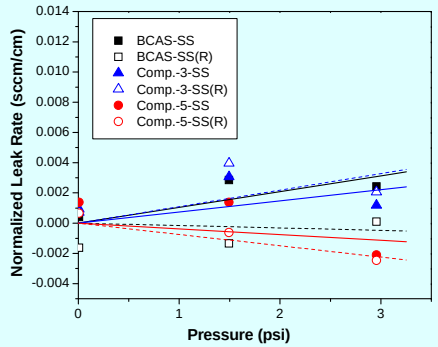

Figure-7: Leak rate versus pressure graphs for various tape-cast sealing gaskets with and without thermal cycle.

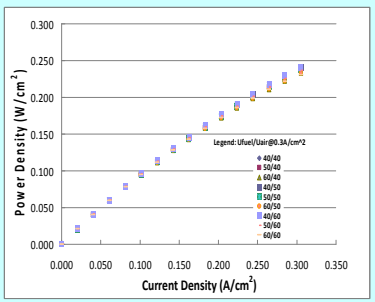

Figure-8: Polarization curves for MSRI 3-cell stack sealed using glass composition -5.

Conclusions:

-The results indicate that glass-MgO composition-5 has the most stable crystalline phases and thermal expansion coefficients over prolonged durations at 800°C.

-It forms clean and stable seal interfaces with the SOFC electrolyte (8YSZ) and Crofer-22 metal foil coated with doped lanthanum chromite.

-Helium leak tests suggest that compositions-3 and 5 have short-term sealing characteristics that are as good or better than BCAS glass.

-Satisfactory sealing performance was demonstrated for a 3-cell stack using tape-cast gaskets of composition-5.

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