Thermogravimetric Analysis on External Wall Coating Material of Cold Crucible Induction Melter

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1. Introduction

The cold crucible induction melter (CCIM) of HanUl Vitrification Facility (UVF) consists of 48 sectors with mica sheet spacers. The temperature of external wall maintains designed temperature with help of cooling water system, while the temperature of melted glass in the CCIM is 1,100~1,200°C. The mica spacer, located between the sectors, attributes the electrical insulation of the sectors and mechanical flexibility of the CCIM. The external wall coating material maintains the physical structure of the CCIM and obstructs the emission of internal heat energy transfer, as shown in Fig. 1.

The composite structure, hybrid structure of glass fabric and chemical, is usually used for the fabrication of external wall coating to achieve both mechanical strength and high temperature resistivity.

Fig. 1. Photo of external wall coating material of CCIM.

2. Experiment

2.1 General information

The glass fabric and chemical, usually epoxy or silicon resin, based composite structure is used for external wall coating materials. Since the primary object of coating material is the obstruction of high thermal energy from the melted glass, the selection of suitable coating material with good heat resistance is important.

In this study, the thermal property of the glass fabric and chemical based composite structures were studied.

2.2 Fabrication of glass fabric and epoxy composite structure

The epoxy, bisphenol A type, resin and curing agent were mixed for 0.5 hr with adequate mixing ratio. The prepared glass fabrics (W/L=5/10 cm) were immersed for 0.5 hr to achieve sufficient surface reaction. And they were dried for 24 hrs at the ambient atmosphere as shown in Fig. 2.

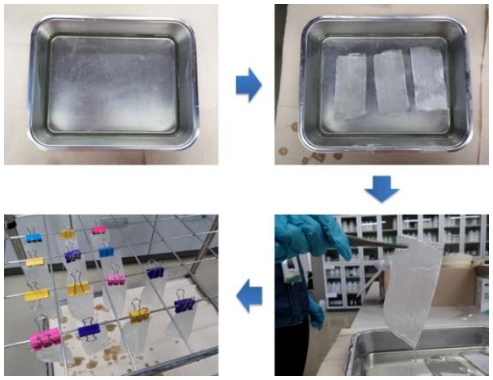

Fig. 2. Fabrication of glass fabric and epoxy composite structure.

2.3 Fabrication of glass fabric and silicon composite structure

The silicon resin for heat resistance purpose was manually coated on the prepared glass fabrics (W/L=5/10 cm) at the room temperature. Since the viscosity of the silicon resin is far higher than epoxy resin, the previous immersion method was not applicable for the silicon coating. The coated samples were dried for 24 hrs as shown in Fig. 3.

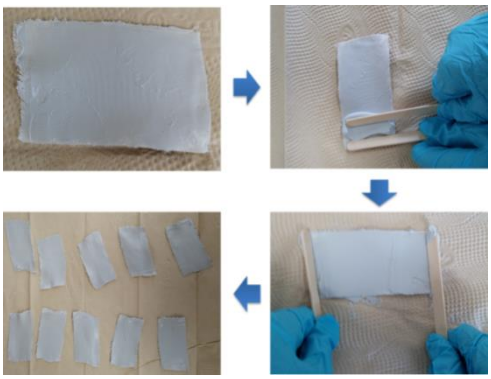

Fig. 3. Fabrication of glass fabric and silicon composite structure.

3. Discussion

The designed operation temperature of CCIM external wall surface is around 110°C. Since the heat conduction in inorganic material is lower than metal, it was suggested that the standard temperature for analysis is 150°C. All the thermogravimetric analysis (TGA) was repeated 3 times for accurate characterization. The measurement condition of TGA is O_2/N_2 atmosphere with 10°C/min (30~800°C).

3.1 TGA of glass fabric

The TGA of glass fabric, shown in Fig. 4, indicates that the glass fabric is thermally stable under 800°C. The gradual weight loss was observed from 200 to 800°C. It seems that the weight loss of 1.47% is originated from surface coating of glass fiber for the separation and synthesis of fabric [1].

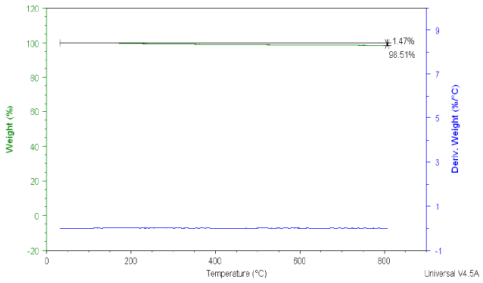

Fig. 4. TGA of glass fabric.

3.2 TGA of glass fabric and epoxy composite

The TGA of glass fabric and composite is shown in Fig. 5. The result indicates that all the organic materials convert to CO_2 and evaporate, when the temperature reaches 650°C. The weight loss ~100°C is attributed to thermal decomposition of thermally unstable carbon related component.

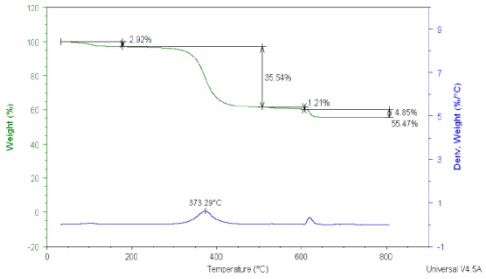

Fig. 5. TGA of glass fabric and epoxy composite structure.

3.3 TGA of glass fabric and silicon composite

The TGA of glass fabric and composite is shown in Fig. 6. It is generally known that the functional group, attached to the silicon, determines the property of the silicon resin. The composite is stable until the temperature reaches 200°C. It seems that the carbon based functional groups are gradually decomposed, above 200°C. According to the analysis, the glass fabric and silicon composite is thermally stable at ~110°C, designed operation temperature of CCIM external wall.

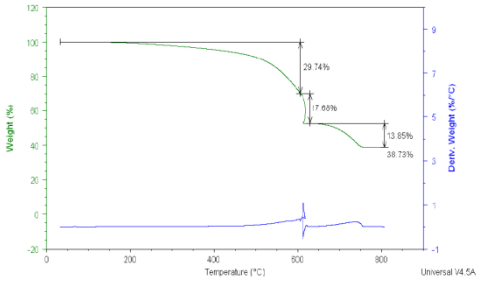

Fig. 6. TGA of glass fabric and silicon composite structure.

4. Conclusion

The glass fabric and chemical, epoxy and silicon resin, composite was studied for the application of external wall coating materials for CCIM. The TGA of composites indicated that the glass fabric and heat resistance silicon composite was stable until the temperature reaches 200°C.

REFERENCES

[1] Soo Lee, “Modification of Glass Fiber Bundle with Functionalized Coupling Agent and Phenolic Resin”, Journal of the Korean Oil Chemistry Society, 33(1), 168-175 (2016).