Study on Mechanical Strength of External Wall Coating Material for Cold Crucible Induction Melter

Young Hwan Hwang*, Seokju Hwang, Mi-Hyun Lee, and Cheon-Woo Kim

KHNP-CRI, 70, 1312-gil, Yuseong-daero, Yuseong-gu, Daejeon 34101, Republic of Korea

*yhhwang7@khnp.co.kr

1. Introduction

The cold crucible induction melter (CCIM) of HanUl Vitrification Facility (UVF) consists of 48 sectors with mica sheet spacers. The internal water based cooling system maintains the temperature of external wall to the designed temperature, while the temperature of melted glass is over 1,000 °C. Since the induced current is the primary energy for the glass melting, the each sector is electrical separated using mica spacer for the efficient operation. The mica spacer also allows the sufficient mechanical flexibility of the melter. The external wall coating material of melter offers the solid maintenance of the physical structure of the melter and obstructs the emission of internal heat energy transfer, as shown in Fig. 1. The hybrid structure of glass fabric and heat resistance type chemical is favored for the external coating materials to achieve both good mechanical strength and high temperature resistance.

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

2. Experiment

2.1 General information

The glass fabric, mainly consists of E-glass, and high thermal resistance chemical, epoxy and silicon, are used for the fabrication of composite structure. The fabrication process and basic thermal property of the fabricated composite films are found in previous study [1]. Since the primary object of the external coating materials is a solid maintenance of physical structure of sectors, the construction of composite structure is important.

In this study, the mechanical property of the external coating materials is studied.

2.2 Tensile strength analysis

The tensile strength of the glass fabric and chemical composite is analyzed using INSTRON 5969. The measurements, using ASTM D 3039-14, were carried out at the room temperature, 95, 110, 150, 200, and 250 °C to understand the effect of temperature with 5 mm/min. The Fig. 2 shows the measurement of tensile strength using INSTRON 5969. The tensile strain analysis was repeated 3 times and recorded at the measurement temperature.

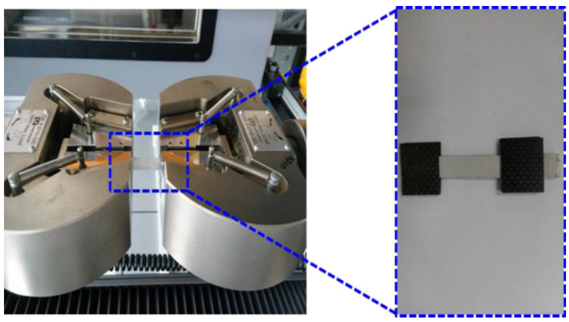

Fig. 2. Measurement of tensile stress using INSTRON 5969.

3. Discussion

3.1 Tensile strength of glass fabric

The tensile strength of glass fabric with respect to temperature is shown in Fig. 3. As the temperature increases, it is observed that the tensile strain slightly decreases. The average tensile strain at the 110 ^{o}C, melter operation temperature, is 0.63 kN.

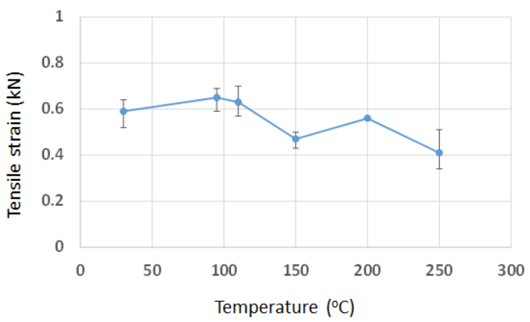

Fig. 3. Tensile strain of glass fabric.

3.2 Tensile strength of glass fabric/epoxy composite

The tensile strength of glass fabric and epoxy composite with respect to temperature is shown in Fig. 4. As the temperature increases, it is observed that the tensile strain slightly decreases, similar to the glass fabric. The average tensile strain at the 110 ^{o}C, melter operation temperature, is 0.5 kN.

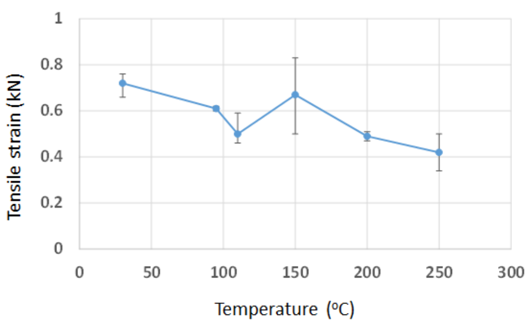

Fig. 4. Tensile strain of glass fabric and epoxy composite.

3.3 Tensile strength of glass fabric/silicon composite

The tensile strength of glass fabric with respect to temperature is shown in Fig. 5. As the temperature increases, it is observed that the tensile strain slightly decreases, similar to the glass fabric. The average tensile strain at the 110 ^{o}C, melter operation temperature, is 0.62 kN. According to the measurement data, it is concluded that the fabric and epoxy or silicon composites exhibit sufficient tensile strain to maintain melter structure. In addition, the glass fabric and silicon composite, which is superior to epoxy based composite in terms of thermal resistance, shows the highest tensile strain at the high temperature.

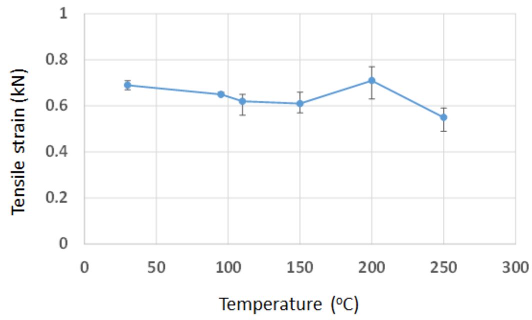

Fig. 5. Tensile strain of glass fabric and silicon composite.

4. Conclusions

The composite coating materials, hybrid materials using glass fabric and chemical, were studied for the employment to external coating materials for CCIM. The mechanical property, in terms of tensile strength, analysis indicated that the composite exhibits sufficient mechanical strength and enables the solid maintenance of the sectors. As a result, it seems that the glass fabric and silicon composite has a high-potential for the application of external coating material of CCIM, in terms of thermal and mechanical properties.

REFERENCES

[1] Young Hwan Hwang, Seok-Ju Hwang, Mi-Hyun Lee, Cheon-Woo Kim, “Thermogravimetric Analysis on External Wall Coating Material of Cold Crucible Induction Melter”, Proc. of the KRS 2017 Spring Conference, 15(1), May 24-26, 2017, Busan (2017).