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Improvement of Fire Resistance of Fiber Reinforced Plastics

Takumi Sugiura[1)] Yuto Goto[1)] Asami Nakai[1)] Masayuki Okoshi[1)]

Haruhiko Nakamura[2)] Makoto Murai[2)] Junichi Ogawa[3)] Takuya Tanigawa[3)] Shuhei Yasuda[3)]

1) Gifu University
1-1 Yanagido, Gifu, 501-1193, Japan
2) DaikyoNishikawa, Co. , Ltd
5-1 JIke Industrial Park, Higashi Hiroshima, Hiroshima 739-0049, Japan
3) Mazda Motor, Co., Ltd.
3-1 Shinchi, Fuchu-cho, Aki-gun, Hiroshima 730-8670, Japan

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1. Introduction

Fiber reinforced plastics are expected to replace metal materials as electric automobile components, because they are lightweight and have high mechanical properties. However, plastic is flammable, and there is a high risk of fires, such as ignition and spread of fire to plastic due to heat generated by electronic components. Therefore, it is necessary to improve fire resistance in order to apply plastic to electric automobile components. If an analytical model that can simulate combustion similar to a real fire, it is possible to make prototypes using a variety of materials and efficiently improve fire resistance. As a basic research for developing an analytical model to improve fire resistance of fiber reinforced plastics, a molding in which the surface of the plastic covered with continuous fibers such as glass fiber and carbon fiber was tested for combustion. They were evaluated for the effects of the presence and types of the covering material on combustion characteristics.

2. Experimental methods

Fig.1 shows a schematic of a plastic covering method using a continuous fiber substrate. This was a method of welding the covering material to the plastic by heating and pressurizing. It was possible to reinforce moldings by partially attaching functional material. The molding method was to stack the plastic and the covering material, heat it, and pressurize it for a few minutes on the mold with heaters. Then, the molding was obtained after solidification and demolding processes. In this research, the plastic was covered with glass fiber reinforced plastics and carbon fiber reinforced plastics using polypropylene resin. The thickness of the covering material was 0.5mm and 1.0mm.

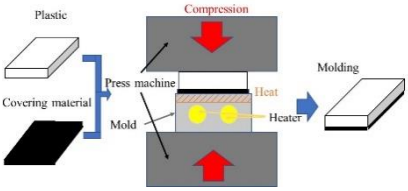

Fig.1 Schematic of a plastic covering method.

The molding was evaluated by a combustion test. Fig.2 shows an appearance of combustion test. The combustion test was conducted using a cone calorimeter. The sample size was 30×30 mm. The experimental method was compliant with ISO 5660. Total heat release value, heat release rate, combustion start and end times were obtained by the test. In this research, an uncovered plastic(PP+GF), a molding with a 0.5 mm thick GFRP(GF-UD-0.5), a molding with a 1.0 mm thick GFRP(GF-UD-1.0), a molding with a 0.5 mm thick CFRP(CF-UD-0.5), a molding with 0.5 mm thick CFRP(CF-UD-0.5), and a molding with 1.0 mm thick CFRP (CF-UD-1.0) were tested.

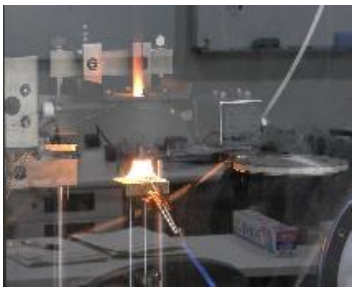

Fig.2 Appearance of combustion test.

3. Result

Fig.3 shows a relationship between heat release rate and time. It was confirmed that covering the surface suppressed heat release rate and increased the time to peak heat release rate from Fig.3. For the effect of the thickness of the covering material, heat release rate was suppressed by increasing the thickness. For the type of reinforcing fiber for the covering material, heat release rate with CFRP was lower than that with GFRP. It was considered that glass fiber and carbon fiber were non-flammable materials, so they prevented the spread of fire. In addition, covering the surface made combustion time longer. It was assumed that the amount of resin as a fuel for the covering material increased and continuous fiber had higher thermal conductivity than resin. Heat was transmitted to the continuous fiber and it made the plastic difficult to burn. These results show the benefit of covering the surface of the plastic with fiber reinforced plastics.

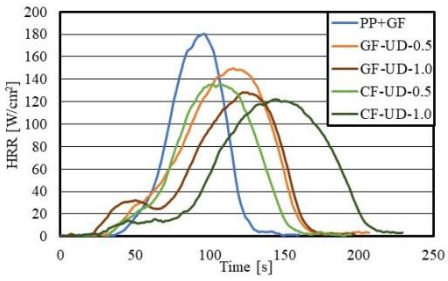

Fig.3 Relationship between heat release rate and time.