INTERFACIAL EFFECT ON THE FRACTURE MECHANISM IN GFRP COMPOSITES

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ABSTRACT

This paper represents the effect of interface on the fracture mechanism in glass fibre reinforced plastic (GFRP) composites. The results exhibit that the reinforced interface causes the stress concentration near the edge of a broken filament. The mean fragment length has decreased with an increase in the tensile stress and finally reached a value of 0.3 mm. The interfacial effect gives rise to the progressed fracture in GFRP composites.

INTRODUCTION

The industrial manufacturing of glass fibres started in 1930's for use in filters and insulations. Glass fibres currently comprise more than 90% of the fibres used in polymer composites. There are five major types of glass used to make glass fibres. These are A-glass (high alkali), C-glass (chemical), D-glass (low dielectric constant), E-glass (electrical) and S-glass (high strength), out of which the last two types, due to their superior mechanical properties, are most widely used in composite roofings, pressure vessels, containers, tanks, pipes, etc. [1].

E- glass is a low alkali, aluminum boro solicate glass and is based on a mixture of alumina, boric acid, calcium carbonate and magnesia. Silane coupling agents are applied to processing of glass fibre reinforced plastic (GFRP) composites to reinforce the interfacial strength through the chemical function of the coupling agents. The interfacial reinforcement mechanism is based on the chemical bonds of silane coupling agents to resin and glass surface [2]. It does not explain mechanical properties, of GFRP composites in connection with the interfacial structure formed by the silane coupling treatment. The mechanical strength of the composite material is influenced by the amount and the adsorption behavior of the silane coupling agent. Therefore, it is essential to obtain information on the mechanical behavior of interface.

An investigation has been carried out to study effects of pouring temperature, degasification, mould pre-heat temperature and alloy composition on casting fluidity of Al-Si-Mg alloys used for gravity die casting.

The present work was focused to study the silane interfacial effect on the fracture process of embedded single E-glass fibre. The tensile test was employed to study the fracture process.

EXPERIMENTAL PROCEDURE

Materials Used :

Glass fibre	- E-glass yarn (10 μm in dia.)
Matrix	- Epoxy resin
Silane Coupling agent	- Y-axilino propyltrimethoxy silane
Hardening catalyst	- Triethylenetetramine

PREPARATION OF GFRP COMPOSITE SPECIMENS

The E-glass fibre was dipped into different concentrations of liquid silane coupling agent and cured at 100°C for 30 min. The cured fiber was washed with distilled water and dried in the open air. The epoxy resin was mixed with 10 parts of hardening catalyst. The mixture was agitated thoroughly and then defamed in vacuum for 10 minutes. The mixture was poured into a mould holding a glass fibre with tension of 3.0gf in the centre and subjected to curing at 75 °C for one hour.

The dimensions of test specimens were 100mm length x 10mm width x 1 mm thickness.

TESTING

The specimens were subjected to the tensile test at a test speed of 0.05 mm/min. The tensile tests were interrupted a few times within a period of testing to measure the fragment lengths and the fracture positions along the fibre length with a polarization microscope.

RESULTS AND DISCUSSIONS

Fragment Length in Fracture

Fig. 1 shows the change of the mean fragment length in the specimen with change of stress. The fragment length decreases with increase in the tensile stress, and finally reaches a value of 0.3 mm.

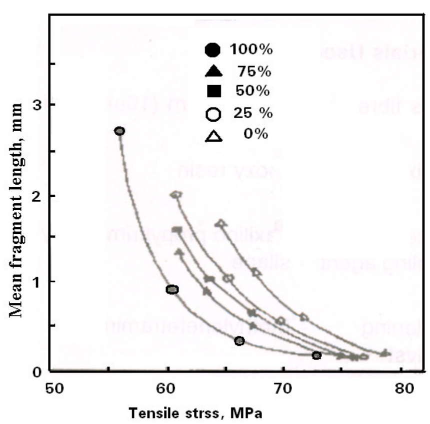

Fig. 1 Effect of silane treatment on fragment length in fracture process

The fracture progresses increasing with the adsorbed amount of silane coupling agent. This is due to the chemical bonding between silane coupling agent, glass fibre and epoxy resin. The chemical bonding generates the reinforcement at the interface.

Fracture Positions and Intervals

Fig. 2 illustrates the fracture positions and intervals along the fibre length. The reinforced interface causes the stress concentration near the edge of broken filament so that it is liable to break at the fracture position. The stress concentration may be generated to the chemical structure of the silane interface bonding to glass fibre and matrix.

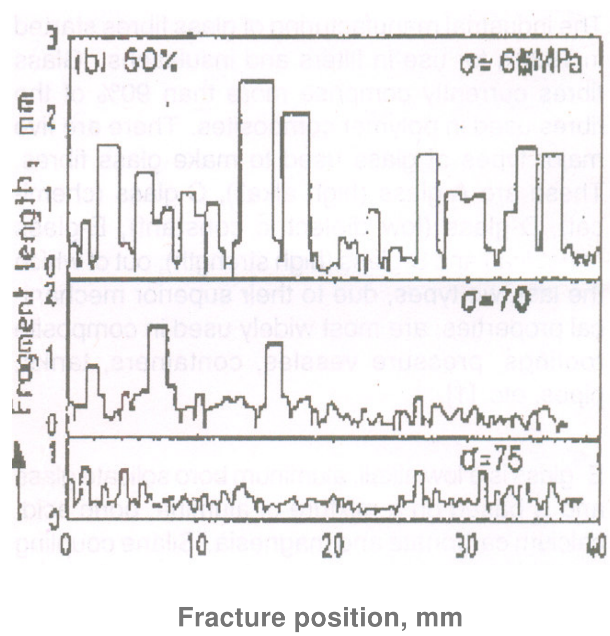

Fig.2 Fracture positions and fracture intervals along fibre length

CONCLUSIONS

The interfacial reinforcement reflects the progressed fracture rather than the instantaneous fracture. The reinforced interface resulted due to chemical reaction causes the stress concentration near fibre ends.

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