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Integration of glass fibre structures in aluminium cast parts for CFRP aluminium transition structures

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Abstract

Weight saving is targeted in different industrial sectors. This leads to increasing numbers of applications of fibre composites for primary structural components. In consequence the use of composites made of FRP and metals are highly attractive.

Within the investigations of the researcher group 'Schwarz-Silber' (FOR 1224) funded by the DFG (Deutsche Forschungsgemeinschaft) new interface structures for advanced FRP-aluminium hybrid structures are currently investigated. By these combinations a weight reduction by a factor of two is aspired compared to conventional riveting connections.

This paper focuses the research in the so called fibre concept and the integration of glass fibre structures in aluminium parts via casting technologies. During the investigations of integral CFRP-Al compounds, glass fibre structures were integrated directly into near-net-shaped castings. The challenges are the infiltration of fibre structures with aluminium and a reproducible positioning in the cast part. In this study the high pressure die casting and the Lost Foam casting processes were examined.

Keywords: CFRP-aluminium composites; glass fibres; hybrid structure; high pressure die casting; Lost Foam, transition structure

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1. Motivation and Introduction

One of the examined approaches to realize a transition structure between aluminium and carbon fibres is the so called fibre concept. In this concept two different methods are investigated. The first approach integrates fibre loops into the aluminium castings and ’entangles‘ them with carbon fibre (CF) loops. Within the second approach, glass fibre laminates are integrated into the castings, which are gradually replaced with C-fibre fabrics subsequently to pass into the CFRP component. Both approaches share the subsequent infiltration with epoxy resin (see Figure 1). The transition structure is made of glass fibres in order to achieve an electrochemical decoupling between aluminium and the carbon fibres. A direct contact between these two materials would lead to an increased corrosive degradation on the aluminium because of the electrochemical noble CF compared to aluminium [1] [2].

The presented approaches relate to the integration of the glass fibre structures in aluminium parts using casting technologies and the associated challenges.

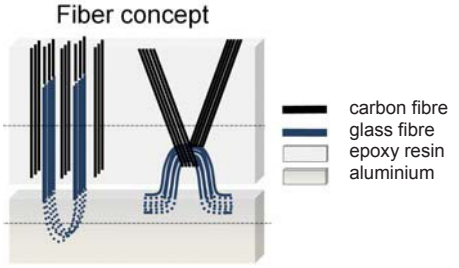

Figure 1: schematic structure of the fibre concept

A major challenge is to stabilize and tense the fibres in the high pressure die casting process due to the high pressures and speeds of the molten aluminium during the filling of the mould [3]. In cooperation with the Faserinstitut Bremen e.V. (FIBRE) different cast inserts were created to investigate the stability of the fibres during the process. Another challenge is to cover a part of the fibres to achieve a partial infiltration, so that it will be possible to connect carbon fibres to the glass fibre structure in subsequent steps to build up the CFRP-laminate without contact to the aluminium. The covering material has to be removed from the fibres after the casting process without leaving any deposits on it to fulfil the requirements of a clean fibre-surface for good adhesion to the epoxide.

Due to these challenges another casting technique is under investigation: the Lost Foam casting process. In this case the sealing can be achieved with the help of the forming sand. The positioning of the fibre structure in the EPS (expanded polystyrene) model is quite easy. In contrast to high pressure die casting, the Lost Foam casting process is a method that is suitable for small quantities but allows a very high degree of freedom in the design of the casting. The melt is filled into the cavity without additionally acceleration or high pressure, comparable to conventional sand casting techniques.

2. Experimental

2.1. Glass fibre preforms

The manufacturing of fibre preforms for integration in the cast component was performed by ’tailored fibre placement‘ (TFP) [4]. The advantages of this method are unrestricted loop geometry, a reproducible process