POLITECHNIKA ŚLĄSKA
WYDZIAŁ INŻYNIERII MATERIAŁOWEJ

Rozprawa doktorska

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Możliwości kształtowania mikrostruktury kompozytów piana węglowa – magnez

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Katowice, sierpień 2020 r.

Abstract

In the presented thesis possibilities of design the microstructure and properties of a new carbon open-celled foam (C_{of}) – magnesium composites were studied. Performed literature studies shown that wetting phenomena in a magnesium – carbon system do not occur, however, there are effective methods to fabricate magnesium matrix composites reinforced with different types of carbon reinforcement. Conception of interpenetrating phase composites is well known from literature, mainly from aluminum matrix composites reinforced with ceramic foams.

Experimental studies included determining the possibilities of self-infiltration of C_{of} with different porosities (20, 45, 80 ppi) by liquid magnesium and its alloys (AZ31 and RZ5 alloy), analysis of the bonding between magnesium matrix and carbon foam formation with the use of sessile drop method with additional pressure. Composites were fabricated using gravity infiltration and pressure infiltration, from which the second one shows higher effectiveness and potential for the industrial application.

The microstructure of fabricated composites was examined using stereoscopy, light microscopy, quantitative metallography and scanning electron microscopy with energy dispersive spectroscopy. Additionally, microhardness of matrix, composites compressive and flexural strength were examined as well as tribological properties in ambient temperature using "pin-on-disc" method.

Performed studies have shown that self-infiltration of carbon foams by liquid magnesium or its alloys do not occur and bonding between components has the oxide nature. During wettability tests in C_{of} – Mg system the formation of oxide layer have been observed *in situ.* Based on obtained results, structural scheme of formation of bonding between C_{of} – Mg was proposed (Fig. 1).

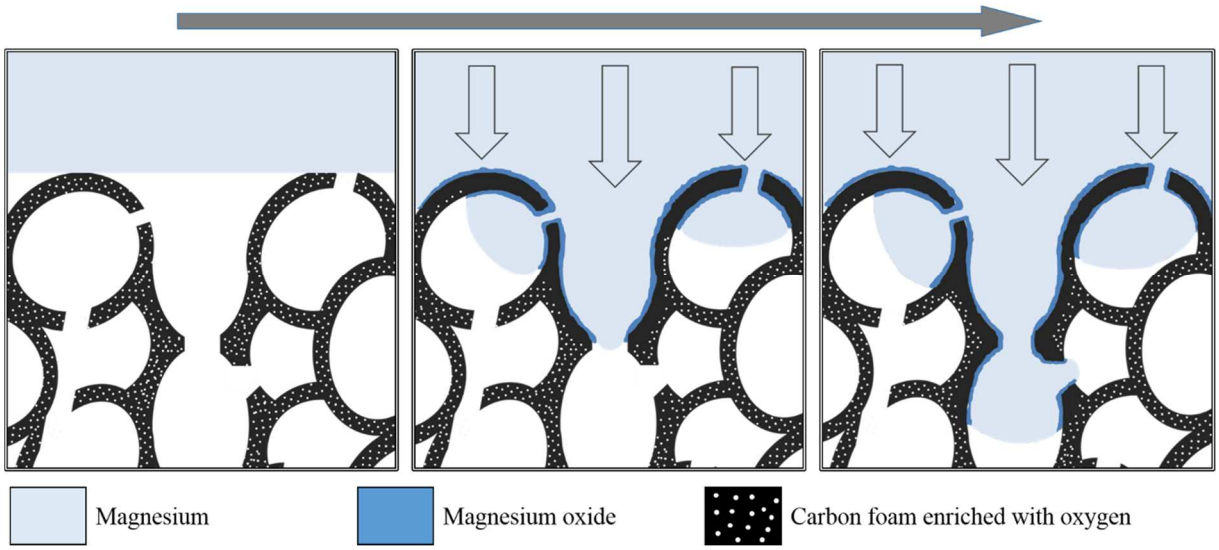

Fig. 1. Schematic presentation of interaction and bonding between the open-celled carbon foam and liquid magnesium [W3]

The influence of carbon foam cells size on microstructure, microhardness of matrix, compressive strength, flexural strength and tribological properties of composites were characterized. Decreasing cells size resulting in matrix' grain refinement, increasing its microhardness and compressive strength and stiffness of the composite.

It was shown that application of the commercial AZ31 and RZ5 alloys allow to obtain the composites with higher mechanical properties, however strengthening effect in comparison to matrix is lower. Infiltration of carbon foams with magnesium alloys in the same conditions (temperature, pressure and time) is more complex than in the case of pure magnesium, and microporosity of composites is higher. The application of commercial alloys instead of pure magnesium also changes the fractures morphology, including the carbon open-celled foam, interface and matrix.