Characterization of Al/AlN composites produced in situ

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Aluminum matrix composites (AMCs) have gained a considerable interest in automotive and aerospace applications due to their light weight combined with higher stiffness, elastic modulus and strength, as well as better thermal stability and wear resistance as compared with aluminium alloys.

Recently, an increasing attention has been paid to aluminium nitride as a reinforcing phase in AMCs. The addition of AlN, due to its good physico-chemical, mechanical and thermal properties, allows to enhance the modulus, strength, hardness, wear resistance and high temperature performance of aluminium alloy matrix. The main advantage of the aluminium nitride over commonly applied in AMCs reinforcing phases is good bonding to aluminium matrix, higher wettability in aluminium, as well as stability of aluminium/aluminium nitride interface.

In this work an attempt to produce aluminium matrix composite reinforced with dispersed aluminium nitride (AlN) via reaction of liquid aluminium and magnesium nitride (Mg_3N_2) has been made. The latter was introduced into the metal bath in a form of a green compact. It was expected that the introduction of Mg_3N_2 as an nitrogen-bearing substrate into Al melt would allow to obtain an in-situ reaction leading to a formation of an aluminium nitride (AlN) reinforcing phase dispersed in the Mg-strengthened aluminium matrix.

The produced material was investigated by means of X-ray diffraction measurements (XRD), optical microscopy (OM), scanning and transmission electron microscopy (SEM,TEM) as well as microhardness tests. Microstructure investigations showed that absence of an external mixing of metal melt led to a formation of inhomogeneous structure of the material: composite zone with a very high content of reinforcing particles and an area of unreinforced aluminium. The composite zone was localized in the initial area of Mg_3N_2 compact and its immediate vicinity. Energy Dispersive Spectrometry (EDS) analysis combined with X-ray diffraction (XRD) analysis confirmed presence of two main phase in the material: aluminium solid solution (with up to 4 at.% of Mg) and aluminium nitride. Microhardness tests showed very high values of hardness in the composite zone, reaching up to about 500 HV, as compared with ~25HV in the unreinforced Al region.