POLITECHNIKA ŚLĄSKA
WYDZIAŁ INŻYNIERII MATERIAŁOWEJ

PODSTAWY TECHNOLOGII WYTWARZANIA POWŁOK Zn-Al-Mg O PODWYŻSZONEJ ODPORNOŚCI KOROZYJNEJ METODĄ ZANURZANIA POJEDYNCZYCH WSADÓW

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Katowice 2020

Abstract

Zinc coatings are one of the most popular anti-corrosion protection of steel. The composition of the alloys commercially available for hot-dip galvanizing is continuously improving to achieve even higher corrosion resistance. Currently, Al and Mg are increasingly popular additives for continuous galvanizing. These elements allow to achieve a much higher corrosion resistance. Moreover, due to the content of light elements in the coating, the weight of the coating is reduced, and consequently also the material costs of producing the coating. The obtained outer layer of ZnAlMg coatings among others consists of an eutectic, this provides higher hardness, and thus better resistance to scratching and other mechanical damage. Better corrosion resistance reduces the cost of operation and renovation, and the possibility of using thinner, more resistant coatings contributes to lower zinc consumption.

ZnAlMg coatings, used in the continuous method, however, are more challenging for the batch method. The addition of Al over 0.02% causes rapid reactions with the steel substrate and the formation of Fe-Al intermetallic phase particles, contaminating the bath and also settling on the surface, which causes roughness and coating defects. Al also reacts with the flux used in the batch method - it leads to the formation of coating discontinuities. The best method of obtaining batch ZnAlMg coatings seems to be the double dip method, which allows the use of the same galvanizing process, without changing the chemical preparation of the surface and the process temperature.

The research of ZnAlMg alloys and ZnAl(MgSi) coatings including their production process, structure and corrosion resistance showed that in baths based on ZnAlMg alloys in the concentration range of Al from 3 wt.%. up to 11 wt.% and in the range of Mg concentration up to 3 wt.%. it was possible to produce continuous coatings by a two-stage dipping process at a temperature corresponding to the traditional hot-dip galvanizing process. The addition of Si allows to delay the delamination of the diffusion layer of the coating and to limit the excessive increase in the thickness of the coatings with the addition of Al. The final composition of the bath ensuring the established temperature (445-455°C), high corrosion resistance and the best technological processability is the ZnAl11Mg30.3Si (ZAMS) bath. The coatings obtained in the ZAMS bath show a layered structure. The diffusion layer is formed by the $FeAl_3$ phase (heterogeneous structure and a significant amount of Zn), and the outer layer is formed by Zn and Al-rich dendrites with interdendritic spaces filled by Zn/Al /$MgZn_2$ eutectic. Such a structure provides up to 3 times better corrosion resistance compared to traditional zinc coatings.