鋅鎳合金電鍍鋼板製程之最佳化研究

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ABSTRACT

This study aims at establishing the "processing-structure-mechanical properties-formability" relationship for ZnNi alloy electrodeposited sheet steels so that an optimal processing can be made. ZnNi coating was electroplated at a current density of 70 A／dm2 from chloride bath which Ni+2 content varying from 8 to 16%. The bath was kept at a PH value of 4.5, and a temperature of 60°C. Bath composition was monitored via ICP method. GDS and ICP analyses were used to quantify the average Ni content of the coatings. The mechanical properties of coated sheet steels were measured by lap-shear test, cylindrical cupping test, and 60 degree V-bending. Furthermore, low-temperature impact, low-temperature U-bending, and low-temperature stone chipping tests were performed so that coating formability under severe conditions can be evaluated. The surface morphologies of as-plated samples and flash coatings after various degree of etching were observed using an SEM with EDS analyzer. XRD technique was used to identify the phases of ZnNi alloy coatings, and to measure the internal stresses of the flash coating at various stages of etching. Along with TEM observation, TEM was used reliably to characterize the microstructures of coated sheet steels via selected-area electron diffraction.　　It has been demonstrated that flash coatings of 2g／m2 to 4g／m2, after being etched in PH0.8 HCl solution for 10 to 20 seconds, can improve the adhesion of NiZn coating to steel substrate. The coated sheet steels with the above-mentioned flash coating as under-layer and an major overlay with Ni content of 10 to 12% exhibit best formability and low-temperature stone-chipping resistance. The relief of internal compressive stress of flash coating and the mechanical interlocking between overlay and cracked flash coating lead to the enhancement of adhesion of ZnNi coating to steel substrate. Mechanical interlocking effect is evident for the existence of the V-shape microcracks characterized using cross-sectional TEM specimens. An optimal etching procedure for exacting development of microcracks must be adjusted according to the Ni-content of the flash coating. Although ZnNi coatings with Ni-content ranging from 8 to 16 wt.% were identified as single γ phase via XRD analyses, TEM observations have resolved the different grain structure for various ZnNi deposits. ZnNi deposit with 8% Ni exhibits a fine-grained structure. A columnar grains interdispersed with fine grains structure was observed for ZnNi deposits with 10% and 12% Ni-content. For coating with 16% Ni, a well-defined columnar grain structure was observed.　　With its excellent corrosion resistance, weldability, and paintability, ZnNi alloy electrodeposition technology appears to be the most promising one among the various Zn-coating technologies provided that the formability of ZnNi coated sheet steels can be improved. The findings of this work provide the scientific basis for the steel industry to optimize their ZnNi coating products, and for the development of advanced coated-products.

Keywords : 鋅鎳合金 ; 電鍍鋼板

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