Design of Novel Metallic Corrosion Protective Coatings on Steel Sheet by Means of Thin Film Technologies

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Abstract:

For steel strip used in automotive applications an effective corrosion protection has to be provided, which is often realized by conventional zinc or zinc alloy coatings with a thickness of 7-10 µm. New vacuum processes allow the deposition of thin multi-layer coating systems having an improved corrosion resistance and – due to a significantly reduced thickness - a better workability. Within this work, a multi-layer coating system consisting of three metal layers (zinc, magnesium and aluminium) with a total thickness of less than 3 µm was deposited on steel sheet using a PVD- or a combined electro galvanizing/PVD-process. A thermal treatment was applied in order to adjust the structure of the coating system.

The coatings were characterized by means of scanning electron microscopy (SEM), glow discharge spectroscopy (GDOS) and X-ray photoelectron spectroscopy (XPS). The corrosion behaviour was examined in a cyclic corrosion test according to standard 621-415 of the German car makers (VDA) using specific flange samples. A significant increase in flange corrosion resistance of thin film coatings compared to commonly used 7.5 µm electro-galvanized zinc (EG) coatings can be attested. Furthermore, thin film coatings showed an excellent laser-weldability in overlap mode without gap, which is relevant for an efficient use in automotive applications.

The excellent corrosion resistance and good workability achieved indicates that PVD processes for metallic layers are promising to be enhanced as an advanced industrial technology for coated steel strip products.