

Development of Environmentally Friendly Non-Chrome Conversion Coatings for Cold-Rolled Steel

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ABSTRACT

Steel producers use various organic and inorganic coatings to protect cold-rolled steel (CRS) sheets from corrosion during shipment and storage. It is well known that CRS sheets can be protected from corrosion by galvanizing, phosphating, chromating, topcoating with organic, or their combinations. The chromate rinsing is particularly effective for preventing white rusting of galvanized steel. But there is an increasing interest in a replacement for the chromating process because of environmental and health concerns. The objective of the present work is to develop a chrome-free conversion coating for steel sheets.

Various carboxylic acids and their salts have been studied for coating phosphated electrogalvanized (EG) steel sheets, including 10-undecenoic acid (UA), oleic acid (OA), and other fatty acids such as stearic acid (SA) and palmitic acid (PA). When they were used alone, or subsequently coated with resin, they could produce a highly hydrophobic surface and improve the corrosion resistance.

Thiols such as 1-octadecanethiol (ODT) can form a self-assembled monolayer on metal substrates. This close-packed monolayer could provide an excellent corrosion resistance for EG steel sheets. It was capable of withstanding 50~60 hours of salt spray test (SST) although its thickness was only a few nanometers. The EG steel itself usually started rusting only after 2~4 hours of salt spray.

In another coating system, thiols were mixed with a conventional resin to improve the corrosion resistance of EG steel. This new technique gave 100~120 hours of corrosion resistance. When the resin was applied directly on EG steel surface, its corrosion resistance was less than 72 hours. It was shown that further optimization of this technique increased the corrosion resistance to 200 hours and more in the standard SST.