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METHOD OF IMPROVING CORROSION RESISTANCE OF STEEL SURFACES AND RESULTING PRODUCT

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ABSTRACT OF THE DISCLOSURE

Method of increasing corrosion resistance of steel surface in which the surface is coated with aluminum, and a film of mixed oxides of silicon and aluminum is deposited over the aluminum-coated surface.

This invention relates to a method of improving the corrosion resistance of steel surfaces and to the resulting product.

It is known that a steel surface can be made more resistant to corrosion by applying a thin coating of aluminum. One method of application is by a vapor-deposition process conducted in a vacuum, as shown for example in Smith Pat. No. 3,277,865 and the prior art cited therein. The usual aluminum coating is extremely thin and does not afford as much corrosion resistance as would be desirable. It is also known to apply to an aluminum-coated steel surface a protective film of silica, as described fo rexample in Gartner et al. Pat. No. 3,177,134. Such film improves the resistance to corrosion over a coating of aluminum alone, but still does not afford maximum protection.

An object of our invention is to provide a method of improving the corrosion resistance of an aluminum-coated steel surface by applying over the aluminum coating a mixed oxide film which affords greater protection than a single-oxide film.

A more specific object is to effect such improvement by applying a surface film composed of mixed oxides of silicon and aluminum in critical ratios.

A further object is to provide, as an article of manufacture, a steel product which has an aluminum coating plus a surface film of mixed oxides of silicon and aluminum.

In accordance with our invention, we first apply to the surface of a steel body, such as a sheet or a continuous strip, a coating of aluminum. We may use any conventional vapor deposition process to apply this coating. Next we apply to the aluminum-coated surface a film of mixed oxides of silicon and aluminum. Again we use known techniques. For example, we may follow a procedure similar to that described in the aforementioned Gartner et al. patent for applying a film of silica alone. We vaporize silicon and aluminum from separate crucibles in a vacuum chamber, to which we admit a small volume of oxygen. The vapors oxidize and a mixture of the oxides deposits on the aluminum-coated surface. By using separate crucibles and separate vaporizing means, we are able to control the rate at which both substances vaporize and thus control the ratio of their oxides in the film. The oxide film consists of about 30 to 60 percent by weight silica and the remainder oxides of aluminum. We prefer about equal parts of each. The minimum effective coating thickness (aluminum plus oxides) is about 0.25 micron. It is essential that we apply the two oxides simultaneously; the corrosion resistance is not nearly as good when we apply the two oxides separately one over the other.

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As a test to determine the corrosion resistance of different samples, we exposed samples alternately to one hour of simulated dew and one hour of artificial sunlight in a Model XWR "Weatherometer." We inspected each sample at least once daily (12 cycles). We considered a sample as having failed when approximately 30 percent of its surface was covered with rust. A 100-cycle exposure is regarded as equivalent to a one-year outdoor exposure in Florida.

In such tests we observed a five-fold increase in the life of a steel sample coated with aluminum to a thickness of 0.1 micron plus a 0.9 micron film of equal parts oxides of silicon and aluminum, compared with a sample coated with aluminum alone to a thickness of 1 micron. The sample coated with aluminum alone failed in 200 cycles, while the other withstood 1000 cycles. Other tests gave results as follows:

Deposit	Total thickness, micron	Ratio	Cycles to failure
SiO_2 over Al oxide deposited separately over aluminum	0.30	33/33/33	32
	0.68	42/42/16	159
	0.81	25/25/50	367
Aluminum oxide over aluminum	0.48	67/33	197
	0.48	33/67	197
	0.68	50/50	197
SiO_2 and Al oxide deposited simultaneously over aluminum	0.36	62(50–50)/38	471
	1.08	87(50–50)/13	1,000

From the foregoing description it is seen that our invention affords an effective method for improving the corrosion resistance of aluminum-coated steel, as well as a product which has improved corrosion resistance. The method is simple and easily carried out in conventional equipment for vapor-deposition coating of steel.

We claim:

1. A method of improving the corrosion resistance of a steel surface comprising applying to the surface a coating of aluminum, and applying over the aluminum coating a film of mixed oxides of silicon and aluminum, said coating and film having a minimum thickness together of about 0.25 micron, said film consisting of about 30 to 60 percent by weight silica and the remainder aluminum oxide.

2. A method as defined in claim **1** in which the oxide film is applied by vaporizing silicon and aluminum simultaneously from separate sources in the presence of oxygen, and depositing the vapors on the aluminum-coated surface.

3. As an article of manufacture, a steel body which has a coating of aluminum and an oxide film overlying said coating, said film consisting of a mixture of about 30 to 60 percent by weight silicon oxide and the remainder aluminum oxides, the two oxides being deposited simultaneously on said coating, said coating and said film together having a minimum thickness of about 0.25 micron.

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