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DIFFUSION COATING PROCESS

Michael C. Carosella, Niagara Falls, N.Y., assignor to Union Carbide Corporation, a corporation of New York

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The present invention relates to a process for providing metal substrates with a diffusion alloy coating. More particularly, the present invention relates to a diffusion alloy coating process in which decarburization of the substrate metal is avoided.

Diffusion alloy coatings have been provided on metal substrates by heating the substrate in contact with coating metal, in elemental form, at low pressures. While a satisfactory diffusion alloy coating is obtained in this manner it has been found that the aforedescribed treatment causes decarburization of the substrate. In the case of steel, this develops a ferritic structure which is detrimental in that it leads to loss of hardness and strength in the coated article.

Since diffusion coated articles have properties which make them advantageous for use in structural applications, in addition to such uses as automobile bumpers and trim, it would be of significant industrial benefit if impairment of the substrate material by carbon depletion could be avoided.

It is therefore an object of this invention to provide a diffusion alloy process for coating metal substrates in which decarburization of the substrate is avoided.

Other objects will be apparent from the following description and claims.

A process in accordance with the present invention for providing a metal substrate with a diffusion alloy coating comprises heating a metal substrate in intimate contact with a carbon bearing alloy of the coating metal, the heating being conducted at a pressure of less than 2,000 microns in the temperature range of about 1000 to 1500° C. for a period of time sufficient to provide the substrate with the desired depth of diffusion alloy coating.

In a particular embodiment of the present invention, a steel substrate, in the form of plate, for example, is placed in a vacuum furnace and carbon bearing chromium metal is placed in intimate contact with the substrate. This can be conveniently accomplished by packing the steel substrate in comminuted high carbon ferrochromium alloy. The aforementioned materials are then heated at a temperature between 1000° C. and 1500° C., at a pressure of less than about 2000 microns, for a time sufficient to provide the desired depth of alloy coating in the substrate. Heating periods of from about 20 to 60 hours have been found to be sufficient to provide alloy coated articles suitable for use in such application as automobile trim, automobile bumpers and the like with the longer heating periods providing greater coating depths of up to about 0.15 inch or more. The alloy surface in the articles produced in this manner are high in chromium, e.g., up to 40%, at the surface of the article with decreasing chromium contents at increasing distances from the surface. Also, importantly, there is substantially no loss of carbon in the substrate as a result of the alloy coating treatment.

In the practice of the present invention in order to avoid any substantial loss of carbon from the substrate, the proportion of carbon in the source of coating metal, e.g., ferrochrome, should be at least about 25 times the proportion of carbon in the substrate. This can be conveniently provided most often with the use of commercially available ferroalloys such as high carbon ferrochrome which contain from 4–9 percent carbon.

However, if, in certain applications, some loss of carbon in the substrate can be tolerated, then coating metal sources containing somewhat lesser amounts of carbon may be used.

The following examples will further illustrate the present invention.

Example 1

A ½ inch plate of 1020 steel was packed in high carbon ferrochrome alloy powder (325 mesh×D) and heated in a vacuum furnace at 1300° C. for 36 hours. The average pressure in the furnace during heating was 70 microns.

Another plate of 1020 having the same dimensions as the first was packed in low carbon (vacuum grade chromium metal powder) (325 mesh×D) and heated under the same conditions, i.e., 1300° C. for 36 hours at 70 microns pressure. Both steel plates were provided with a diffusion alloy coating of chromium as a result of this treatment.

The carbon of the steel plate processed with high carbon ferrochrome was substantially unaffected while the carbon content of the steel plate processed with chromium was depleted to about 10% of its original value as shown in the data of Table I.

TABLE I

Percent carbon in chromium source	Percent carbon in steel plate	
	Before processing	After processing
4.83 (high carbon ferrochrome)	0.17	0.15
0.08 (chromium powder)	0.17	0.016

Example 2

A ½ inch plate of 1020 steel was packed in high carbon ferrochrome alloy powder (100 mesh×D) and heated in a vacuum furnace at 1175° C. for 48 hours. The average pressure in the furnace during heating was 60 microns.

Another plate of 1020 having the same dimensions as the first was packed in low carbon ferrochrome (20 mesh×D) and heated under the same conditions, i.e., 1175° C. for 48 hours at 60 microns pressure. Both steel plates were provided with a diffusion alloy coating of chromium as a result of this treatment.

This carbon content of the steel plate processed with high carbon ferrochrome was substantially unaffected while the carbon content of the steel plate processed with low carbon ferrochrome was depleted to about 30% of its original value as shown in the data of Table II.

TABLE II

Percent carbon in chromium source	Percent carbon in steel plate	
	Before processing	After processing
4.83	0.17	0.14
0.025 (low carbon ferrochrome)	0.17	0.032

What is claimed is:

1. A process for providing a steel substrate with a diffusion alloy coating of chromium metal and avoiding decarburization of steel substrate which comprises heating the steel substrate in intimate contact with ferrochrome having a carbon content of 4–9%, said heating being conducted at a pressure of less than about 2,000 microns in the temperature range of 1000° C. to 1500° C. for a period of time sufficient to provide the desired depth of alloy coating whereby the substrate is provided with a diffusion alloy coating of chromium and decarburization of the steel substrate is avoided.

2. A process for providing a steel substrate with a diffusion alloy coating of chromium metal and avoiding decarburization of steel substrate which comprises heating the steel substrate in intimate contact with carbon bearing chromium metal, the proportion of carbon in the chromium metal being at least about 25 times the proportion of carbon in the substrate.

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RICHARD D. NEVIUS, *Primary Examiner.*

R. S. KENDALL, *Assistant Examiner.*