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PROCESS AND BATH FOR ELECTROSMOOTHING FERROUS METALS

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This invention is concerned with improvements in or relating to the electroplating of a ferrous surface with another metal for protective or other purposes; the invention is particularly concerned with the production of tinplate.

We have found that the porosity of an electro-deposited metal coating on a ferrous surface, more particularly a mild steel surface, can be reduced by electro-smoothing the metal to be plated prior to carrying out the electroplating operation. By electro-smoothing the metal prior to electroplating, any high points of the metal surface are removed; if these high points are not removed they tend to receive a disproportionate amount of deposit at the expense of the surrounding areas, which are then less protected against wear and corrosion.

According to one aspect of the present invention, therefore, there is provided a process of preparing a ferrous surface for electroplating with another metal, which comprises electro-smoothing the surface to be plated in a bath containing acceptor ions with a low diffusion coefficient in order to obtain low limiting current densities for anodic dissolution.

More particularly the present invention provides a process for the production of tinplate in which the steel is electro-smoothed in a bath containing acceptor ions with a low diffusion coefficient in order to obtain low limiting current densities for anodic dissolution and is thereafter electroplated with tin. In the production of tinplate, it has been found that the number of rust spots formed on exposure to a corrosive atmosphere for a given time was similar for a 4 oz./basis box electrodeposit of tin on electro-smoothed mild steel and an 8 oz./basis box electrodeposit on unsmoothed mild steel.

It is particularly preferred to effect electro-smoothing of the ferrous metal to be plated with a new type of electrolytic smoothing bath in which low limiting current densities for anodic dissolution are obtained by using acceptor ions with a low diffusion coefficient, such as the anions of organic hydroxy carboxylic acids. In order to achieve the maximum rate of smoothing, the bath is preferably operated on the rising portion of the anode potential/current graph just below the horizontal portion corresponding to the limiting current density for anodic dissolution.

The composition of such an electro-smoothing bath in which the citrate anion is employed as the acceptor ion is, for example, as follows:

	Gms./litre
Sodium citrate (+2 mols. H_2O)	49–147
Citric acid	2–50
Sodium chloride	5–20

The range of sodium citrate concentrations (49 to 147 gms./litre) quoted in the example above corresponds to 0.5 to 1.5 N solution. Five to 20 gms./litre of sodium chloride, as specified in the example above, corresponds to 3 to 12 gms./litre of chloride ion.

The proportions of sodium citrate and citric acid within these ranges should be such that the pH of the bath is from 4.0 to 6.0.

In order to obtain the maximum rate of smoothing, it is preferred to operate a bath having the above composition with an anode current density of from 50 to 150 amps./sq. foot for from 0.2 to 15 seconds with the bath at a temperature of from 5° to 35° C.

It will be apparent from the rapidity of the electro-smoothing action obtained with baths of this type that they are eminently suitable for inclusion in a high speed continuous electrolytic tinning line for the production of tinplate. Where an electro-smoothing step according to the invention is included in such a high speed continuous electrolytic tinning line all that is required is that a sufficient length of the steel strip, which will be dependent on the rate of travel of the strip, should be immersed in the electro-smoothing bath for each portion of the strip to have the required time of residence in the bath. The advantages of this type of bath for use in this way are (*a*) economy in plant and operating costs due to the use of a low current density, (*b*) high degree of smoothing for quantity of metal removed, and (*c*) low drag-out losses due to the low concentration and viscosity of the bath.

In order that the invention may be more fully understood, the following example is given by way of illustration only:

Example

Mild steel sheet suitable for the production of tinplate was connected as the anode in an aqueous electro-smoothing bath containing:

	Gms./litre
Sodium citrate (+2 mols. H_2O)	98
Citric acid	35
Sodium chloride	10

and having a pH of 4.6. The bath was maintained at a temperature of 22° C. and was operated with an anode current density of 100 amps./sq. ft. It was found that for a treatment time of 0.9 second, a reduction in the surface area of the sheet, as measured by an electrode capacitance technique, of about 33% was obtained. With treatment times of 0.2 sec. and 1.5 sec., the surface area was reduced by 15%.

The electro-smoothed steel sheets thus obtained were then subjected to a conventional electrolytic tinning operation together with a further sample of the same steel sheet which had not been electro-smoothed. The electrodeposited tin coating on the electro-smoothed sheets was less porous than that on the unsmoothed sheet and the tinplate obtained from the electro-smoothed sheets was more corrosion-resistant than that obtained from the unsmoothed sheet.

I claim:

1. A process of preparing low carbon steel for electroplating with another metal, which comprises anodically electrosmoothing the surface to be plated in a bath consisting essentially of water and from 49 to 147 gms. sodium citrate (including 2 mols. water of crystallisation) per litre, from 2 to 50 gms. citric acid per litre, and from 5 to 20 gms. sodium chloride per litre, the relative proportions of sodium citrate and citric acid being such that the bath has a pH of from 4.0 to 6.0.

2. A process for the production of tinplate which comprises the steps of anodically electrosmoothing low carbon steel in a bath consisting essentially of water and from 49 to 147 gms. sodium citrate (including 2 mols. water of crystallisation) per litre, from 2 to 50 gms. citric acid per litre and from 5 to 20 gms. sodium chloride per litre, the relative proportions of sodium citrate and citric acid being such that the bath has a pH of from 4.0 to 6.0 and then electroplating the steel with tin.

3. A bath for electrosmoothing ferrous metals which consists essentially of water and from 49 to 147 gms. sodium citrate (including 2 mols. water of crystallisa-

tion) per litre, from 2 to 5 gms. citric acid per litre, and from 2 to 20 gms. sodium chloride per litre, the relative proportions of sodium citrate and citric acid being such that the bath has a pH of from 4.0 to 6.0.

4. A process of preparing a low carbon steel surface for electroplating with another metal, which process comprises the steps of immersing the surface to be plated in a bath consisting essentially of an aqueous solution of an organic hydroxy carboxylic acid, a water-soluble salt of an organic hydroxy carboxylic acid and chloride ion, the concentration of said salt being from 0.5 to 1.5 N, the concentration of chloride ion being from 3 to 12 gms./litre, and the concentration of said acid being such that the bath has a pH of from 4.0 to 6.0, and then passing a current between said surface, as anode, and a cathode at an anode current density of from 50 to 150 amps./sq. ft., whereby electro-smoothing of said surface is effected.

5. A process for producing tinplate, which process comprises the steps of immersing low carbon steel sheet material in a bath consisting essentially of an aqueous solution of an organic hydroxy carboxylic acid and chloride ion, the concentration of said salt being from 0.5 to 1.5 N, the concentration of chloride ion being from 3 to 12 gms./litre, and the concentration of said acid being such that the bath has a pH of from 4.0 to 6.0, then passing a current between said sheet material, as anode, and a cathode at an anode current density of from 50 to 150 amps./sq. ft., whereby electro-smoothing of said sheet material is effected, and thereafter electroplating the sheet material with tin.

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