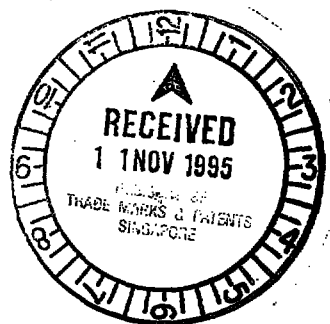


RTMP

Iron having an anti-friction layer.



The invention relates to an iron comprising a metal soleplate which is provided with an anti-friction layer. The invention also relates to a soleplate which is provided with a heating element and an anti-friction layer, said soleplate being suitable for use in an iron.

Irons are generally composed of a housing, usually of a synthetic resin, to which a soleplate is connected. Said soleplate is customarily made of aluminium, but it can alternatively be made from zinc, nickel, copper or stainless steel. In general, a separate layer, which is commonly referred to as anti-friction layer, is applied to the surface of the soleplate facing away from the housing of the iron. During ironing, this anti-friction layer directly contacts the clothes to be ironed. A prerequisite for the proper functioning of the iron is that such an anti-friction layer meets a large number of requirements. For example, the anti-friction layer must, *inter alia*, exhibit satisfactory anti-friction properties on the clothes to be ironed, it must be corrosion-resistant, scratch-resistant, and durable and exhibit an optimum hardness and a high resistance to wear and to fracture. The material of the anti-friction layer must meet extra high requirements because the anti-friction layer is exposed to substantial variations in temperature ranging between 10°C and 300°C. Some of said requirements are more or less contradictory from the viewpoint of materials science.

An iron of the type mentioned in the opening paragraph is known *per se*, for example, from European Patent Application EP-A 217.014. The iron described in said Application comprises a soleplate of aluminium, which is provided with an anti-friction layer of a ceramic material, preferably aluminium oxide. This anti-friction layer is provided by means of plasma spraying. In this process, spherical aluminium oxide particles having a diameter of, for example, 10 microns are heated by means of a plasma jet and sprayed onto the soleplate. In this process, a bonded ceramic layer of aluminium-oxide particles is formed. Subsequently, this anti-friction layer is polished to obtain the desired smoothness.

The known iron has disadvantages. It has been found that the ceramic anti-friction layer has a relatively high porosity and a relatively low corrosion resistance. In addition, the anti-friction properties, particularly the anti-stick properties, of the known layer are not optimal and keeping the layer clean as well as cleaning it has proved to be difficult.

Finally, the processes of providing and polishing the anti-friction layer are expensive and cannot easily be carried out in mass-production.

It is an object of the invention to overcome the disadvantages of the known iron. The invention more particularly aims at providing an iron as well as a soleplate which can be mass-produced at low cost. The anti-friction layer of the soleplate must also have a satisfactory corrosion resistance as well as a low porosity.

These and other objects of the invention are achieved by an iron of the type mentioned in the opening paragraph, which is characterized in that the anti-friction layer consists of a layer of predominantly aluminium oxide which is formed in an electrochemical manner.

An electrochemically formed anti-friction layer has the important advantage that it can be rapidly and cheaply provided on a soleplate in mass-production. In spite of the fact that the electrochemically formed layer is not subsequently subjected to a polishing treatment, its coefficient of friction is optimal for ironing. In addition, the inventive iron has still other favourable properties, such as in particular a high scratch resistance and a high durability of such an electrochemically formed metal-oxide layer. In addition, the resistance to fracture of the anti-friction layer is at least equal to that of the known sprayed layer of ceramic aluminium oxide. The thickness of the metal-oxide layer of the inventive iron is preferably 10 to 50 micrometers, in particular 15 to 25 micrometers.

The expression "electrochemically formed layer" is to be understood to mean herein that the metal at the surface of the soleplate is electrochemically oxidized to form a thin layer of metal oxide. This layer is formed by immersing the surface of, preferably, a polished soleplate and an inert electrode, for example of aluminium, lead or graphite, into a suitable, preferably, acidified salt solution. For this purpose, an AC or DC voltage difference must be applied across the soleplate and the electrode, in which process the soleplate serves as the anode. Specific variants of this process are commonly referred to as (hard) anodizing, eloxing and opalizing.

A favourable embodiment of the iron in accordance with the invention is characterized in that the soleplate is made of aluminium which is processed by means of injection moulding, and in that an intermediate layer is situated between the anti-friction layer and the soleplate.

The manufacture of soleplates from aluminium is preferably carried out by means of injection moulding. Aluminium which can suitably be processed by means of injection moulding comprises a considerable quantity of other elements, such as silicon

and/or magnesium. These additions reduce the melting temperature of aluminium, so that it has the required degree of fluidity at the temperature at which injection moulding is carried out. The quantities of said additions are customarily 5% by weight or more. It has however been found that the manufacture of a homogeneous, electrochemical layer on injection-mouldable aluminium is generally not very well possible. This is caused by the presence of certain types of precipitates in the aluminium. This problem can be solved by an additional layer between the soleplate and the anti-friction layer.

In accordance with another favourable embodiment of the iron in accordance with the invention, said intermediate layer is provided by metal spraying of aluminium. Such a layer formed by metal spraying bonds well to the soleplate of injection-mouldable aluminium. In addition, it has been found that an aluminium-oxide anti-friction layer which is electrochemically provided on said intermediate layer also bonds well and exhibits a satisfactory hardness and a uniform homogeneity.

In an even more favourable embodiment of the iron in accordance with the invention, the intermediate layer consists of a plate of anodizable aluminium which is secured to the soleplate. To secure the plate to the soleplate use can be made of a thermostable adhesive and/or a mechanical connection, for example screws. As can be inferred from the expression "anodizable aluminium", the types of aluminium in question can be effectively treated in an electrochemical manner.

If desired, the anti-friction properties of the soleplate can be further improved by providing the surface of the anti-friction layer with predominantly parallel, linear structures, as described, *inter alia*, in European Patent Application EP-A 378.479. Said structures must be present on the surface of the soleplate before the soleplate is electrochemically treated.

The invention also relates to a soleplate which is provided with a heating element as well as an anti-friction layer. In accordance with the invention, this soleplate comprises a layer which consists predominantly of aluminium oxide and which is formed electrochemically. Such a soleplate can very suitably be used in an iron of the type described hereinabove.

The invention will be explained in greater detail by means of exemplary embodiments and a drawing, in which

the sole Figure shows an iron in accordance with the invention.

It is noted that for the sake of clarity, the components are not drawn to scale.

The Figure shows a steam iron. Said iron comprises a synthetic resin housing (1) whose bottom side is provided with a metal soleplate (2). In this case, the soleplate is made of aluminium which has been shaped by injection moulding. The soleplate (2) is provided with an anti-friction layer (3) on the side facing away from the housing. Said anti-friction layer consists of a layer of aluminium oxide which has been formed electrochemically. In this case, the thickness of the anti-friction layer is approximately 20 micrometers. An intermediate layer (4) is situated between the anti-friction layer (3) and the soleplate (2). As will be described in greater detail hereinbelow, this intermediate layer may be provided by metal spraying of aluminium. However, the intermediate layer (4) preferably consists of a plate of anodizable aluminium which is secured to the soleplate (2) by means of a thermostable adhesive and/or screws. It is noted that the intermediate layer (4) may be omitted if the soleplate is made of anodizable aluminium. Further, it is noted that the invention is not limited to steam irons, but can also be applied to conventional irons without steam-generating means.

The soleplate (2) comprises a heating element (not shown) on the side facing away from the anti-friction layer. As is known *per se*, this heating element may consist of a metal pipe in which a heating wire is provided which is embedded in an electrically insulating material of metal oxides. Preferably, however, use is made of a heating element which consists of a resistive layer of thick-film material which is provided in accordance with a pattern and which is situated between two electrically insulating layers which consist preferably of enamel.

The manufacture and the ironing properties of the iron in accordance with the invention will be explained by means of the following exemplary embodiments.

Exemplary embodiment 1.

In this exemplary embodiment use was made of a soleplate of anodizable aluminium, namely AlMgSi0.5, which was shaped in a metal-removing process (milling). The ironing surface of this sole was degreased by treating this surface with an aqueous solution of sodium phosphate (5-10 wt. %) for 5 minutes at a temperature of 50° C. After an electro-chemical polishing treatment, the surface roughness (R_a) of the ironing surface was 0.5 micrometer.

The ironing surface was subsequently provided with an electrochemically formed anti-friction layer. To this end, said surface was anodized in an aqueous solution of 15-18% sulphuric acid for 30-45 min at a temperature of approximately 5° C. The current

density was 10-30 mA/cm². Under these conditions, a layer of aluminium oxide having a thickness of approximately 25 micrometers was formed on the soleplate.

The anodized layer was subsequently "sealed" in deionized water at a temperature of 98° C. The anti-friction layer thus obtained had a uniform texture and a silver/grey appearance. The soleplate with the anti-friction layer was then secured to a housing and subjected to a number of tests. Measurements showed that the anti-friction layer had an optimum roughness ($R_a = 0.5$ micrometer) and an optimum hardness ($HV > 450$). Drop tests showed that the resistance to fracture was very satisfactory.

Exemplary embodiment 2.

In this case, a soleplate of injection-mouldable aluminium was used. In addition to aluminium, being the main constituent, it also contained 12 wt.% Si. The surface of the soleplate was scoured and ground and subsequently degreased, and wet-chemically etched.

Next, an anodized layer of aluminium oxide was provided on the soleplate in the manner essentially described in exemplary embodiment 1. In this case, a layer thickness of 35 micrometers was provided. It was found that the hardness of the anti-friction layer formed was much lower than that of exemplary embodiment 1. Further visual inspection showed that the texture of the anti-friction layer was irregular and that there were cavities in the layer. In addition, the colour of the layer was irregular. It was found that the scratch resistance of the anti-friction layer was not optimal.

Exemplary embodiment 3.

The ironing surface of an injection-moulded soleplate whose composition corresponds to that of exemplary embodiment 2 was pre-treated by means of sand blasting. A thin layer of pure aluminium was subsequently sprayed on said pre-treated surface. The metal-spraying process took place in an oxygen-containing atmosphere. The layer can be provided by means of flame spraying as well as plasma spraying. The layer formed (thickness 0.1-2.0 mm) bonded well to the injection-mouldable aluminium. The layer predominantly consists of a mixture of aluminium and alumina. The sprayed layer was subsequently ground and polished. Next, an anti-friction layer was electrochemically formed on the sprayed intermediate layer. The thickness of the layer ranges between 15 and 50 micrometers. An aqueous solution of oxalic acid (7%) was used as the anodizing bath. The bath temperature was 20 degrees Celsius, the current density was 2.5 A/dm² and the

anodizing time 50-60 minutes.

After "sealing" of the anti-friction layer at 98°C in demineralised water, the soleplate was secured to a housing. The iron thus manufactured was subjected to a number of measurements. It was found that the anti-friction layer formed had a uniform 'granite' texture and was of a beige-grey colour.

Exemplary embodiment 4.

A thin plate (thickness 2 mm) of anodizable aluminium (type AA 5052 (AlMg 2.5) or type AA 6061 (AlMg1SiCu)) was secured to the ironing surface of an injection-moulded soleplate (see exemplary embodiment 2) by means of a thermostable adhesive (Shin Etsu KE 1830) and screws. Instead of screws, rivet studs can also be used. In this embodiment, the surface of the soleplate did not have to be pre-treated. Both surfaces of said plate had previously been provided with a 40 microns thick aluminium-oxide anti-friction layer in an electrochemical manner. This anti-friction layer was provided on the plate in the manner essentially described in exemplary embodiment 1.

The properties and texture of the anti-friction layer were found to be substantially identical to those of the anti-friction layer of exemplary embodiment 1. Measurements showed that the layer had a suitable coefficient of friction in the case of cotton (static value 0.13 and dynamic value 0.17) and polyester (static value 0.20 and dynamic value 0.21). The scratch resistance was about 5 on Mohs' scale of hardness. The layer further demonstrated a good resistance to wear as well as reasonably good anti-stick properties.

Exemplary embodiment 5.

A thin plate of anodizable aluminium was secured to an injection-moulded soleplate by means of screws and a thermostable adhesive (Toshiba XE-13-A8341). Before the plate was secured to the soleplate, it had been electrochemically provided with an aluminium-oxide layer having a thickness in the range of 15-30 microns. In this case, optimal gliding properties were achieved by a pre-treatment of 9 minutes etching and 1 minute polishing. After anodizing (aqueous solution comprising 7% oxalic acid) and sealing in a customary manner, this anti-friction layer was of a yellowish green colour and had a uniform texture. The properties and the texture (layer roughness and asperity radius) of the anti-friction layer were found to be better than those of the anti-friction layer of exemplary embodiment 4: The friction coefficient on cotton are 0.11 (static) and 0.15 (dynamic) and on

polyester 0.14 (static) and 0.18 (dynamic). The scratch resistance on Mohs' scale of hardness was 6.

Exemplary embodiment 6.

Also in this exemplary embodiment, an iron was manufactured comprising an intermediate layer consisting of a plate of anodizable aluminium provided with a thin anti-friction layer of electrochemically formed aluminium oxide. This iron was manufactured in the manner essentially described in exemplary embodiment 4. In the present exemplary embodiment, the anti-friction layer was subjected to a colouring treatment after anodizing and before "sealing" of the intermediate layer. To this end, the anti-friction layer was introduced into a bath to which a dye was added. To obtain a green colour, first copper sulphate (25 g/l, for 3 minutes at room temperature) was added as a dye, whereafter ammonium sulphate (5 wt. % for 3 minutes at room temperature) was added. To obtain a blue colour, first ammonium oxalate (for 2 minutes at room temperature) was added as a dye and subsequently potassium ferrocyanide (for 2-3 minutes at room temperature) was added. The desired colour was preserved during "sealing" of the anti-friction layer. The other properties of the layer were identical to those of exemplary embodiment 4.

It is noted that the metal-oxide layer can also be coloured by means of other methods which are customarily used in the anodizing process. Examples thereof are, in particular, electrolytic colouring, integral colouring or interference colouring of the layer. It is alternatively possible to use organic dyes instead of inorganic dye salts.

The anti-friction (gliding) property of the coated sole plates is determined by the topography of the surface. The surface topography is characterised by two main parameters:

- Arithmetic mean roughness value (R_a)
- Average asperity radius.

These two parameters (in popular terms: height and sharpness of the peaks) are controllable by the chemical etching and polishing processes of the sole plates prior to anodising.

By varying the chemical etching duration, different R_a values are achieved. The optimum range of R_a value is 0,4 - 0,9 μm . Similarly, by varying the chemical polishing duration, a wide range of asperity radius can be achieved. The optimum range of asperity radius is 100 - 250 μm . With these optimised R_a value and asperity radius, anodized sole plates according to the present invention possesses very low and balanced friction coefficients on many types of fabrics:

FABRIC TYPE and SOLEPLATE TEMPERATURE [°C]	FRICTION COEFFICIENT	
	STATIC	DYNAMIC (at 0.3 m/s)
cotton (200°C)	0.10 - 0.13	0.14 - 0.16
polyester (150°C)	0.13 - 0.16	0.17 - 0.20
silk (150°C)	0.09 - 0.13	0.17 - 0.19
wool (175°C)	0.10 - 0.12	0.16 - 0.18
viscose (200°C)	0.08 - 0.11	0.13 - 0.14
acetate (150°C)	0.10 - 0.12	0.15 - 0.16

It has been found that a soleplate of an iron having an anti-friction layer which is formed by electrochemically oxidizing an aluminium layer has excellent anti-friction properties. In particular the embodiment in which an intermediate layer in the form of an anodizable aluminium plate is provided between the anti-friction layer and the soleplate is considered to be very favourable as it can be manufactured in a simple manner.

Claims:

1. An iron comprising a metal soleplate which is provided with an anti-friction layer, characterized in that the anti-friction layer consists of a layer of predominantly aluminium oxide which is formed in an electrochemical manner.
2. An iron as claimed in Claim 1, characterized in that the thickness of the anti-friction layer ranges between 10 and 50 micrometers.
3. An iron as claimed in Claim 1 or 2, characterized in that the soleplate is made of aluminium which is processed by means of injection moulding, and in that an intermediate layer is situated between the anti-friction layer and the soleplate.
4. An iron as claimed in Claim 3, characterized in that the intermediate layer is provided by metal spraying of aluminium.
5. An iron as claimed in Claim 3, characterized in that the intermediate layer consists of a plate of anodizable aluminium which is provided on the soleplate.
6. An iron as claimed in any of the preceding Claims, characterized in that the arithmetic mean roughness value (R_a) is in the range of 0.4 - 0.9 micrometer, and in that the average asperity radius is in the range of 100 - 250 micrometer.
7. An iron as claimed in any one of the preceding Claims, characterized in that the soleplate is provided with predominantly parallel, linear structures.
8. A soleplate which is provided with a heating element as well as an anti-friction layer and which can suitably be used in an iron as claimed in any one of the preceding Claims.

