

## **Lubrication-free piece or part for a railroad device**

This invention deals with the railroad sector of points and crossings and more specifically to the area of metal to metal friction surfaces of these devices such as to the area of friction surfaces which keep their lubricating properties durably.

Presently, in railroad systems such as switching devices, switches or frogs with movable point, with said devices presenting sliding or displacement between two metal pieces through friction of one against the other represent a problem of rapid wear and tear and seizure at the friction surfaces.

To correct these problems, it is common to grease surfaces in order to withstand friction between the different metal pieces. However, such greasing has some limitations such as that of having limited durability. The grease deposited onto the surfaces in contact is rapidly eliminated when using the device that has such surfaces. Beyond its mere removal, the grease also has the inconvenience of reacting or holding on to dust and particles of its operating environment. The lubricating properties of the grease are then altered at the expense of poor resistance when the surfaces are rubbing against each other.

An alternative solution to greasing consists in producing a friction surface from a layer of lubricating thermoplastic polymers, such as for instance, poly ether ether ketone. However, the deposit of such a polymer on a spheroidal graphite cast iron or steel surface has the downside of rapidly leading to the deterioration of the intrinsic lubricating features of the layer of polymers. For such a situation, a solution consists in using an intermediate amorphous steel layer to limit, or even to eliminate, such deterioration. However, if such solution presents an acknowledged efficiency, the addition of an intermediate amorphous steel layer is an operation that has the downside of having a consequential cost for the friction surface equipment.

The purpose of this invention is to remedy these downsides by proposing a solution at a lower cost than those of the prior state of the art that permits a surface suitable for durable metal to metal friction that operates with resistance strengths to movements with low values.

For that purpose, the invention concerns a piece or part comprising a surface that rubs against another, with this piece or part comprising at least a spheroidal graphite cast iron or steel with the external surface of the part having at least a layer of lubricating thermoplastic polymers,

characterized in that the piece comprises an intermediate nickel-aluminum based layer between the spheroidal graphite cast iron or steel structure and the layer of lubricating thermoplastic polymers.

The purpose of the invention is also a joint characterized in that it comprises at least a piece or part having a friction surface according to the invention.

The invention also concerns a treatment surface of a steel structure for the purpose of reducing the friction resistance and obtaining a piece or part according to the invention, characterized in that the treatment process comprises as a minimum:

- A smoothing step of the surface to be treated;
- A cleaning step of the smoothed surface,
- A spraying step of a nickel-aluminum based composition on the smoothed surface;
- An impregnation or thermal spraying step of a liquid or powder thermoplastic polymer onto the smoothed and cleaned surface;
- A polymerization or finishing step by heating.

The invention also concerns the implementation of at least a piece or part according to the invention in a component of the railroad sector.

The invention will be better understood through the following description that refers at least to a preferred mode of embodiment, given as a non-limiting example, and explained with reference to the attached schematic drawing where figure 1 is the schematic representation of an example of embodiment of the thickness of a piece or part having a friction surface according to the invention.

The invention concerns a duplex surface coating that permits mainly to facilitate the metal-on-metal friction of a sequential or even random translation movement between two counterparts, one stationary and the other mobile, under load, at any time and under severe weather conditions. However, as was explained in this document, the invention is also suitable for friction or rubbing between counterparts set up according to other modes of embodiment.

The invention refers to a piece or part comprising a friction surface 4 rubbing against a second surface with this piece or part comprising at least a spheroidal graphite cast iron or steel structure

1, with the outside surface 4 of the piece or part having at least a layer of lubricating thermoplastic polymers 3 characterized in that the piece or part comprises an intermediate nickel-aluminum based layer 2 located between the spheroidal graphite cast iron or steel structure 1 and the layer of lubricating thermoplastic polymers 3.

Please note that the nickel-aluminum mixture composition contains at least 60% nickel (Ni), with the second major component being aluminum (Al).

This interaction between two surfaces can be accomplished for instance with a joint between two components in a device or between two components belonging respectively to different devices. In that case, the first piece or part comprises at least a spheroidal graphite cast iron or steel structure 1 and an external surface 4 having at least a layer of lubricating thermoplastic polymers 3. Then, the piece or part comprises an intermediate nickel-aluminum based layer 2 between the spheroidal graphite cast iron or steel structure 1 and the layer of lubricating thermoplastic polymers 3.

As part of the invention, the layer of polymers can be carried by the external surface of only one of the pieces or parts to form the joint or by each of the joint parts. Moreover, the invention can be applied to flat joint surfaces as well as to circular or curved surfaces.

As part of the invention, the purpose of the layer of polymers 3 is to play a role of lubricant by permitting to reduce significantly the resistance due to friction of the surfaces 4 of each of the pieces or parts during a displacement of one onto the other. The layer of thermoplastic 3 permits the reduction of the friction coefficient by obtaining a value of 0.2, preferably of 0.15 and ideally of 0.09.

According to a particular and non-limiting mode of embodiment of the invention, at least one of the thermoplastic polymers used is a thermostable semi-crystalline thermoplastic. According to a particular example, the thermoplastic used comprises at least a Poly Ether Ether Ketone also called PEEK. The presence of additives in this composition also permits optimizing the abrasion resistance and the friction coefficient.

The lubrication properties of the layer of thermoplastic polymers 3 can be altered when the joint operates under conditions that present temperature variations, various storms and/or within an environment that facilitates deteriorations, such as for instance, due to the presence of dust.

According to a preferred mode of embodiment that is not limiting for the invention, the durability of the friction surface 4 and among other, the resistance of the friction surface 4 to corrosion is improved by integrating of a nickel-aluminum based intermediate layer 2 between on the one hand the spheroidal graphite cast iron or steel structure 1 and on the other hand, the layer of lubricating thermoplastic polymers 3.

A special feature of the invention also consists of improving the durability of the lubricating properties of the layer of polymers 3 by restraining the wear and tear of the layer of polymers 3 thanks to interlinking the layer of polymers 3 and the surface of the spheroidal graphite cast iron or steel structure 1 which would permit combining the properties of each of these layers.

This interlinking takes place thanks to the formation of a relief 5 on the external surface of the spheroidal graphite cast iron or steel structure 1. The cavities of this relief 5 are then, at least in part, filled by the nickel-aluminum based intermediate layer 2. The layer of polymers 3 that covers the intermediate layer 2, then unifies this relief 5 and the friction surface 4 of the piece or part.

This way, the layer of polymers 3 embodies an external layer formed by a first thickness 6, in depth, that fills at least partially the cavities of the relief 5 of the spheroidal graphite cast iron or steel structure 1 surface covered by the nickel-aluminum based intermediate layer 2 and by a second thickness 7, at the surface, that forms the contact surface 4 where friction of the piece or part takes place.

According to a special feature of embodiment, when structure 1 of the piece or part is made of spheroidal graphite cast iron, the nickel-aluminum based intermediate layer 2 produces an isolation of the spheroidal graphite particles. This isolation permits a separation between the spheroidal graphite and the layer of the lubricating thermoplastic polymers 3. In addition, the nickel-aluminum based intermediate layer 2 intervenes to remedy the problem of heterogeneity that exists in structure 1 between the graphite meshes and the metallic matrix of the cast iron.

Producing a friction surface according to the invention involves several steps of a treatment process which permits achieving a piece or part according to the invention. These different steps correspond at least to the following:

- A step of smoothing the surface to be treated;
- A cleaning step of the smoothed surface;
- A step for spraying a nickel-aluminum based composition 2 onto the smoothed surface;
- An impregnation step or of thermal spraying of a liquid or powder thermoplastic polymer onto the nickel-aluminum based surface 2,
- A step for polymerization or finishing by heating the deposited thermoplastic.

According to an example of non-limiting embodiment of the invention, the thermoplastic polymer is impregnated on the friction surface by a spray using a compressed air gun.

According to an example of embodiment, after polymerization, the thermoplastic layer 3 has a thickness of more than 10  $\mu\text{m}$ , preferably greater than 15  $\mu\text{m}$  and ideally greater than 20  $\mu\text{m}$ . The thermoplastic layer 3 enables to reduce the friction coefficient by obtaining a value of 0.2, preferably of 0.15 and ideally of 0.09.

According to a special feature of non-limiting embodiment of the invention, preferably during the placement of a polymerized thermoplastic layer, the process comprises various steps that enable an improvement of the corrodibility of the friction surface with the formation of a nickel-aluminum layer 2 onto which is placed the polymerized thermoplastic layer 3. These different steps also correspond at the following:

- a degreasing step of the spheroidal graphite cast iron or steel surface,
- a smoothing step of the spheroidal graphite cast iron or steel surface;
- a thermal spraying step of at least a substratum included in a list made up of nickel (Ni) and aluminum (Al).

According to a preferred but non-limiting mode of embodiment of the process for producing a surface of the invention, the process comprises several steps that enable to associate more intimately the polymerized thermoplastic layer 3 and the top surface of structure 1 that bears this thermoplastic layer 3. Production of this intimate association also involves the following:

- An abrasion step of the spheroidal graphite cast iron or steel surface by spraying corundum until a specific given relief surface condition is obtained;
- A cleaning step of the abraded steel surface.

These abrasion steps are undertaken prior to a step that deposits the polymerized thermoplastic layer 3 and a spraying step of a nickel-aluminum based composition 2 onto the surface of the spheroidal graphite cast iron or steel structure 1.

According to an example of embodiment, abrasion of the spheroidal graphite cast iron or steel surface is done by a Cristalba F40-F60- type corundum or any other type guaranteeing the absence of iron oxide. This corundum enables a roughness for which the Ra is lower than 20µm, preferably below 10 µm and ideally between 7µm and 9µm.

Producing a relief on the external surface of the steel or cast iron structure 1 forms an assembly of several cavities 5 distributed at this surface. During the deposit of the layer of thermoplastic polymers and among other during the impregnation step of the liquid polymer, this polymer fills the various cavities of the relief of the steel or cast iron structure 1 surface.

Consequently, the friction surface shows, in thickness, under the so-called layer of thermoplastic polymers 3, a thickness portion 6 at which the surface of the steel or cast iron structure 1 covered by the nickel-aluminum based intermediate layer 2 and the thermoplastic polymer are interlinked. This special thickness portion 6 of the friction surface is involved among other in improving the durability of the friction surface. Indeed, during the implementation of the friction surface, the layer formed by thickness 7 alone of the polymerized thermoplastic 3 has a hardness and resistance to wear and tear that is inadequate to guarantee sufficient durability. However, after a duration t1 during which the friction hardness supports progressive wear and tear, this external layer of thermoplastic polymer alone 7 disappears. The surface that supports the friction is then assumed by the external surface of thickness 6 of the steel or cast iron structure 1 covered by the nickel-aluminum based intermediate layer 2 wherein the nickel-aluminium based intermediate layer 2 and the thermoplastic polymer 3 are interlinked. The external surface on which the friction takes place is then formed by a surface alternation of the steel and cast iron structure 1 and the thermoplastic polymer surface 3. The alternation thus permits a combined association between the hardness of the steel or the cast iron with the lubricating properties of the thermoplastic polymer 3. The friction surface thus permits a combined association between hardness and lubrication that permits durably over time t2 maintaining the lubricating properties of thermoplastic polymer 3. Association of the thermoplastic polymer layer 3 with the nickel-aluminum based intermediate layer 2 thus permits reducing the friction coefficient by obtaining a value of 0.2, preferably of 0.15 and ideally of 0.09. The friction surface of the invention thus permits ensuring a low resistance durability supported by the friction surface.

Needless to say, the invention is not limited to the mode of embodiment described and shown in the attached drawings. Modifications are possible such as with respect to constituting the various components or by substituting technical equivalents, without going beyond the protection domain of the invention.

## CLAIMS

1. Piece or part comprising a friction surface (4) that rubs against a second surface, with this piece or part comprising at least a spheroidal graphite cast iron or steel structure (1), with the external surface (4) of the piece or part having at least a layer (3) of lubricating thermoplastic polymers characterized in that the piece or part comprises an nickel-aluminum based intermediate layer (2) between the spheroidal graphite cast iron or steel structure (1) and the layer (3) of lubricating thermoplastic polymers.
2. Piece or part according to claim 1 characterized in that the surface of the spheroidal graphite cast iron or steel structure (1) onto which is arranged the nickel-aluminum based intermediate layer (2), produces a relief (5) that is at least partially filled by the nickel-aluminum based intermediate layer (2).
3. Piece or part according to any of claims 1 or 2, characterized in that since its structure (1) consists of spheroidal graphite cast iron, the nickel-aluminum based intermediate layer (2) produces an isolation of the spheroidal graphite particles.
4. Piece or part according any of claims 1 to 3, characterized in that at least a thermoplastic polymer comprises at least a thermostable semi-crystalline thermoplastic.
5. Piece or part according to any of claims 1 to 4, characterized in that at least a thermoplastic polymer comprises at least a polyether ether ketone.
6. Joint forming a sliding assembly characterized in that it comprises at least a piece or part having a friction surface (4) according to one of claims 1 to 5.
7. Treatment process of a surface of a spheroidal graphite cast iron or steel structure (1) for achieving a reduction of the friction resistance and obtaining a piece or part according to one of claims 1 to 5, characterized in that the treatment process includes at least:
  - a step for smoothing the surface to be treated;
  - a cleaning step of the smoothed surface;
  - a projection step of a nickel-aluminum based composition (2) onto the smoothed surface,
  - an impregnation or thermal spraying step of a liquid or powder thermoplastic polymer (3) onto the nickel-aluminum based surface (2).
  - a polymerization or finishing step by heating.
8. Treatment process of a steel surface according to claim 7, characterized in that the process comprises, also, prior to the aforementioned steps:
  - A degreasing step of the spheroidal graphite cast iron or steel surface,
  - A smoothing step of the spheroidal graphite cast iron or steel surface,

- A thermal spraying step of at least a substratum included in a list that contains among other nickel and aluminum.
9. Treatment process of a steel surface according to one of claims 7 or 8, characterized in that the process comprises at least:
- an abrasion step of the surface by corundum spraying until a surface is obtained with a specific relief,
  - a cleaning step of the abraded steel surface.
10. Implementation of at least a piece or part according to any of claims 1 to 5 in a component used for railroad applications.