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METHOD OF FLAME SPRAYING GRAPHITE TO PRODUCE A LOW FRICTION SURFACE

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This invention relates generally to the preparation of low friction surfaces. More particularly this invention relates to a method of preparing low friction surfaces by flame sprayed graphite.

Flame spraying is a relatively new field of science concerned with the mechanical coating of solid bodies by spraying them with molten or vaporous particles. Flame spraying has solved many problems in the preparation of thermal resistant, chemical resistant, electrical resistant and abrasion resistant surfaces in that many ceramic, metallic and nonmetallic materials can be deposited which were not previously amenable to coating. Furthermore, many types of base materials can now be coated by flame spraying which could not be plated or covered by previous types of coating procedures.

Although the powder particles as sprayed are at extremely high temperatures, being either molten or vaporized, their cooling rate upon deposition is extremely fast so that the base material is seldom heated to temperatures in excess of 200° F.–500° F. Because of this low heating effect and because the resulting bond is essentially a mechanical bond, almost any surface suitably prepared can be coated. Such surfaces would include almost all the metals and most ceramics, glasses, plastics and woods. Furthermore, the low heating effect is particularly desirable because the plasma spraying process does not affect other desirable properties of the base material.

The coating produced by flame spraying does not usually run together to form a continuous solid coating, but rather the coating remains a series or interlocking network of particles, usually possessing about 5 to 10 percent porosity. It will be appreciated that such porosity may or may not be desirable depending upon the use of the coated material. However, if porosity would present problems it could be readily overcome by providing thicker coating or multilayered coating.

One of the most desirable areas of application for flame spraying has been in the preparation of wear resistant surfaces. Although flame spraying has provided many advancements in wear resistant and low friction surfaces, there still remain a few materials which cannot be flame sprayed but have desirable surface properties. One of these materials is graphite. Graphite, needless to say, is an excellent solid lubricant and would be an ideal coating on surfaces subjected to hard wear. Heretofore, however, graphite has not been amenable to flame spraying because, unlike most materials, graphite does not melt at high temperatures. Attempts to plasma spray graphite have generally failed because graphite sublimes rather than melts and therefore it has not been possible to produce a momentarily molten particle of graphite which can then condense on the cooler base material.

I have found, however, that a good graphite surface can be deposited by flame spraying if the graphite powder is first coated with a thin metallic shell such as nickel or cobalt. Any metal other than nickel or cobalt can be used which can readily be flame sprayed. Thus, the metal coating serves to suppress the volatilization of the graphite. In effect, it is this metal itself that is being sprayed, the metal particles having a graphite core. Upon contact with base material, the coated graphite particles "open up" to expose the intergraphite material. The resulting surface comprises a network of graphite particles within a matrix of metal, such as nickel or cobalt. This surface, then, if lightly abraded, has a extensive area of exposed graphite giving the surface remarkably low friction characteristics.

Accordingly, it is an object of this invention to provide a surface having an extremely low friction quality.

It is another object of this invention to provide a method for depositing graphite onto any solid base material.

It is still another object of this invention to provide a method whereby graphite can be successfully deposited by flame spraying techniques.

These and other objects and advantages are fulfilled by my invention as shall become apparent from the following detailed description.

The metallic coated graphite powders to be sprayed are available commercially in several grades. For example, nickel coated graphite, such as 85 Ni/15 C and 75 Ni/25 C may readily be obtained. Any of these powders may be used. However, those powders having the greatest content of graphite will generally result in the better low friction properties, while those powders having the higher nickel content will generally result in a firmer bonded coating.

The particle size of powder to be sprayed is not overly important as long as it flows readily in the spraying system. Generally the small particles will yield a smoother surface. Aside from the above considerations, it is immaterial which powder is used.

According to one practice of my invention, the piece to be coated is selected such as the portion of a shaft in contact with a bearing, or the bearing surface itself or any surface where friction is prevalent. The base material to be coated must first be slightly roughened by such means as abrading, grit blasting or the like. This is done so that the sprayed coating will anchor solidly into the irregular surfaces of the base material. Once the surface has been roughened, it is ready for flame spray coating.

To perform the actual flame spraying, any of the commerically available flame spraying machines may be used. Some of these machines are sold under the following trademarks: "Plasmatech" (Valley Metallurgical Processing Company, Essex, Connecticut); "Linde Flame-Plating" (Linde Company, Indianapolis, Indiana); and "Plasma Flame" or "Plasma Fax" (Thermo Dynamics Corporation, Lebanon, New Hampshire). Although the mechanism and the principles under which these various machines operate may vary widely, the end result is the same. That is, all these machines are capable of spraying molten particles or vaporous materials onto solid objects.

For the practice of this invention it is not material which of these systems is utilized since this invention is concerned only with the powders which are sprayed and the resulting sprayed surface. Thus the procedure to follow when spraying will not be elaborated here since spraying procedures are well known to those skilled in the art. Published examples of such spraying procedures may be found in numerous literature references.

In actual operation satisfactory results are obtained by spraying through an inert atmosphere such as argon at about 400 amps and 20 to 30 volts. The thickness of the coating may vary from 3 to 20 mils. Coatings less than 3 mils are too thin to supply sufficient graphite, while coating in excess of 20 mils is generally brittle. The thickness of the coating achieved between 3 and 20 mils is not material except insofar as the overall life of the coating is concerned. That is, the thicker coatings will of course last longer.

Once the coating is deposited to the desired thickness, it may be lightly abraded to make the surface smooth and to further expose the graphite. This is most easily done

by hand as with emery cloth or the like. Thereafter the piece may be utilized with the sprayed surface characterized by excellent low friction properties.

To aid in a fuller understanding of my invention the following example is presented as a method by which the invention may be practiced. This example however is meant to be only exemplary and should not limit the scope of the invention.

Example

A seat from a metallic seal arrangement, made of stainless steel, was grit blasted to provide a roughened surface. Nickel-graphite powder of the following physical composition was inserted in the feeder of a standard plasma type spraying gun:

85 wt. percent Ni/15 wt. percent C.

Mesh size:

100–200	percent	0–10
200–325	do	40–70
−325	do	30–60
Apparent Density	gm./cc.	1.1–1.2

Using argon gas as the powder carrier as well as for the arc, the Ni/C powder was sprayed onto the steel seat using about 400 amps and 25 volts. The resulting sprayed surface was lightly abraded with emery paper to give a graphite surface showing much less friction and better sealing ability than the original steel seat alone.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of applying a low friction coating onto the surface of an article comprising, flame spraying said article with a metallic powder wherein each metallic grain has a graphite core.

2. The method of claim 1 wherein the said metallic powder having a graphite core, comprises from 65 to 85 percent metal selected from the group consisting of nickel and cobalt, and from 15 to 35 percent graphite.

3. The method of applying a low friction graphite coating to an article surface comprising the steps of:

(a) heating metal coated graphite powder consisting of about from 15 to 35 weight percent graphite and about from 65 to 85 weight percent metal coating, until said metal coating becomes molten;

(b) applying the graphite powder particles having the molten metal coating to said article surface by flame spraying means;

(c) allowing said molten metal to freeze and cool on said article surface so that metal will "open up" exposing graphite particles on the surface; and

(d) lightly abrading the cooled surface to smoothen said surface and expose additional graphite particles.

4. The method of applying a low friction graphite coating to an article surface comprising the steps of:

(a) heating metal coated graphite powder consisting of from 15 to 35 weight percent graphite and from 65 to 85 weight percent metal coating, said metal coating selected from the group consisting of nickel and graphite;

(b) applying said molten metal coated graphite particles to the article surface by flame spraying means;

(c) allowing the said molten metal to freeze onto the article surface and cool to "open up" exposing graphite particles on the surface; and

(d) lightly abrading the cooled surface to smoothen said surface and expose more graphite particles.

5. A low friction surface formed by flame spraying the surface of an article with a metallic powder selected from the group consisting of nickel and cobalt, said powder having a graphite core.

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