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PROCESS OF METAL COATING METAL OBJECTS TO FACILITATE SHAPING THE SAME

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This invention relates to a process for coating metal objects to facilitate the shaping of such objects. More particularly, it relates to the preparation of the surface of those metals which are difficult to fabricate because of the seizing and galling characteristics of the metals during working operations, and the subsequent coating of the prepared surface with a tenaciously adherent metallic lubricant.

It has long been known that relatively hard metals and metal alloys such as steels may be rendered much more amenable to deformation by imparting a coating of relatively soft metal such as lead to the surface of the steel. The soft metal coating serves as a lubricant in such operations as wire drawing, metal bending or other cold forming operations. In order for the lubricant to function properly, it is necessary that the metal coating adhere tenaciously to the entire surface of the difficultly workable metal substrate and that the metallic lubricant possess a work hardening characteristic which is less than the work hardening characteristic of the base metal. With some combinations of metals, the metallic lubricant is readily applied and the process is carried out with a minimum of difficulty. With certain other metals and alloys, on the other hand, it has been found that the complete removal of oxides from the surface of the metal constitutes a major obstacle to the uniform coating of the base metal in the manner necessary for satisfactory metal working. In instances in which the base metal hardens rapidly when subjected to deformation and is also a metal which forms a tenacious oxide on its surface, the problem is doubly acute.

I have now discovered the means for overcoming the difficulties heretofore associated with the provision of a suitable metallic lubricant coating on such metals. In accordance with my invention I first prepare a flux composition with a suitable solvent action on the metal oxides adhering to the base metal and float this flux on a bath of a molten metal having the desired lubricity. A metal object to be subsequently worked is passed through the layer of molten flux whereby any superficial oxides are removed from the surface of the metal and at the same time the object is superficially heated to a slight extent. Thereafter, without subsequent exposure to the atmosphere or to any oxidizing environment, the fluxed metal object is immersed in a molten bath of the metallic lubricant for a suitable interval of time. Upon withdrawal from the molten bath, the metallic object is found to possess the desired coating of metallic lubricant free from streaks or other irregularities.

Among the metals which form tenacious oxides and which have been found to be difficult to fabricate because of pronounced tendencies to seize and gall are the transition metals which have lately been rapidly increasing in commercial importance, and particularly titanium, zirconium, tungsten, molybdenum and chromium. My invention is applicable to these metals and to alloys in which these metals are present in such amounts that the oxide film formed on such alloys is largely the

oxide of one of the named metals, e. g. stainless steels high in chromium.

The novel flux composition constituting one aspect of my invention comprises at least one alkali metal chloride from the group consisting of lithium, sodium and potassium chlorides, together with aluminum chloride and in some instances one or more additional metal chlorides as circumstances may warrant. For reasons of economy, ease of operation and to simplify the materials of construction, it is desirable that the flux composition have a relatively low melting point. In addition, the amount of fuming is generally less when operations are conducted at lower temperatures. The proportions of the aforementioned flux components are also significant. It has been found that fluxes with melting points well below 300° C. are formed when the proportions of aluminum chloride in the aluminum chloride-alkali metal chloride portion of the flux is roughly between about 50 mol percent and 80 mol percent of the aluminum chloride-alkali metal chloride portion of the mixture and the amount of any additional metal chlorides present is not greater than 50% by weight of the total flux composition and preferably 1–25% by weight of the total, and that such fluxes have the desired solvent action on the oxides generally present on the named metals or alloys. Because of their low melting point, the fluxes are particularly well suited for use in conjunction with low-melting metal baths of lubricants such as lead, tin, cadmium, indium, zinc, or alloys of these metals with one another or with other metals.

The flux composition is generally freshly prepared each time it is to be used. If desired, the several constituents in dry powder form may be mixed in the desired proportions and stored in air-tight bottles prior to use. The composition is prepared by melting the mixture of chlorides in a suitable vessel, covered to avoid the loss of aluminum chloride which is volatile at relatively low temperatures. Upon heating the mixture to about 300° C., the aluminum chloride appears to melt first and form a mushy phase with the alkali metal chloride, which on continued heating turns into a clear melt.

Chlorides of various metals may me added to the flux and melted therewith. I have found it to be particularly advantageous to add limited amounts of the chloride of the coating metal to the flux.

The following examples will serve to further illustrate the practice of my invention:

Example I

A flux composition was prepared by charging 3 parts by weight of aluminum chloride and 1 part by weight of sodium chloride into a glass beaker. The beaker was covered with a watch glass and heated to about 300° C. at which temperature a clear melt formed. Into this melt there was added about 1800 grams of lead shot and on continued heating the lead was readily melted forming a molten pool beneath the flux. A plate of stainless steel (Type 410) was immersed in the flux and then dropped into the molten lead bath. On withdrawal from the molten lead bath, the stainless steel was found to be covered with an adherent coating of lead. The plate was bent back and forth without cracking or peeling the lead. The supernatent flux layer was decanted and a a similar piece of stainless steel was dipped directly into the molten lead. The coating was streaky and readily separated from the base metal wherever oxide was present on the surface. This illustrates the benefits of the preliminary treatment with the oxide dissolving flux.

Example II

A flux was prepared as before by melting a mixture of six parts by weight of aluminum chloride, two parts

by weight of zinc chloride and between one and two parts by weight of sodium chloride. Solid zinc was added to the flux. On continued heating, the zinc melted and formed a separate layer beneath the flux. A piece of titanium as dipped in the flux and held in the molten flux to remove any adherent oxide and then dipped directly into the zinc. The resulting zinc coated titanium was rolled to a 50% reduction with no noticeable separation of the coating from the titanium. The experiment was repeated with zirconium, molybdenum, and stainless steel with equally satisfactory results.

Example III

A flux was made up consisting of 3 parts by weight of aluminum chloride, 1 part by weight of sodium chloride and 1 part by weight of zinc chloride. About 700 grams of this flux was melted in a stainless steel vessel, and 1200 grams of lump tin were added to the melt. The vessel was heated until the tin melted, then a sheet of tungsten was immersed in the flux for one minute and lowered into the molten tin. When the tungsten was removed, a tightly adherent metallic tin coating was observed on the surface. Molybdenum was coated by the same procedure.

Example IV

A flux was made up consisting of 3 parts by weight of aluminum chloride, 1 part by weight of sodium chloride and 1 part by weight of zinc chloride. About 700 grams of this flux was melted in a stainless steel vessel and 1200 grams of lump tin plus 400 grams of zinc were added to the flux. The vessel was heated until both metals had melted. Then the solution was stirred to insure homogeneity. A piece of molybdenum was immersed in the flux for one minute and lowered into the tin-zinc alloy. When the piece was removed, a tin-zinc coating adhered to the surface.

Example V

A mixture consisting of 3 parts by weight of aluminum chloride, 1 part by weight of potassium chloride and 1 part by weight of stannous chloride was melted in a glass beaker under a watch glass cover. A clear melt formed at about 300° C. To the molten flux 2000 grams of tin were added which readily melted to form a layer beneath the flux. A piece of zirconium was immersed in the flux and moved back and forth to insure thorough contact over the entire area of the zirconium. Then it was plunged into the molten tin and held there for about two minutes. When withdrawn, it was found to have a bright tin coating which did not flake off under repeated hammering with a ball peen hammer.

Example VI

A flux was prepared as before by melting a mixture of three parts by weight of aluminum chloride, one part by weight of sodium chloride and one part by weight of zinc chloride. The application of heat was continued while pieces of metallic zinc were dropped into the flux. When the zinc had melted, a rod of titanium was immersed in the flux and moved gently back and forth therein. The fluxed rod was dropped into the zinc layer and then withdrawn, covered with a coating of zinc of considerable thickness. The rod was cold drawn successfully to a size reduction of over 70% without intermediate annealing. Upon completion of the drawing operation, the zinc coating was readily removed by means of a nitric acid treatment.

Similar experiments were performed with each of the aforementioned low-melting coating metals under various fluxes composed of aluminum chloride and an alkali metal chloride in the proportions previously stated whereby the metals titanium, tungsten, zirconium, molybdenum and stainless steel alloys were cold worked after being successfully coated with the various metals. In instances where the coating metal work hardened less severely

than the base metal, the base metal was successfully cold worked extensively without any intermediate annealing. It will be obvious to those skilled in the art that alloy coatings could be applied in the same manner by substituting a molten alloy for the molten metal, per se, and that the coatings could either be retained on the base metal or removed by known techniques.

I claim:

1. The method of cold working an object formed of a transition metal from the group consisting of titanium, zirconium, molybdenum, tungsten and chromium with an adherent metalilc coating of a low melting metal from the group consisting of tin, cadmium, indium, lead and zinc which comprises: forming a molten bath of the low melting metal, covering the molten metal with a flux consisting essentially of between 50 mol percent and 80 mol percent of aluminum chloride and between 50 mol percent and 20 mol percent of at least one alkali metal chloride of the group consisting of lithium chloride, sodium chloride, and potassium chloride and containing a minor amount of a chloride of the low melting metal, immersing the transition metal object in the flux and thence into the molten metal bath and withdrawing the coated metal object from the metal bath and thereafter cold working the transition metal object, so coated.

2. The method of cold working a transition metal object composed of a metal from the group consisting of titanium, zirconium, tungsten, molybdenum, chromium and alloys which are composed principally of at least one of said metals provided with an adherent metallic coating to assist in cold working the object which comprises: forming a molten bath of a low-melting metal of the group consisting of lead, tin, cadmium, indium, zinc, and alloys of said metals with one another, covering the molten metal with a flux consisting essentially of between 50 mol percent and 80 mol percent of aluminum chloride and between 50 mol percent and 20 mol percent of at least one alkali metal chloride of the group consisting of lithium chloride, sodium chloride and potassium chloride, immersing the transition metal object in the flux and thence into the molten metal bath and withdrawing the coated metal object from the metal bath and thereafter cold working the transition metal object, so coated.

3. The method of cold working a transition metal object composed of a metal from the group consisting of titanium, zirconium, tungsten, molybdenum, chromium and alloys which are composed principally of at least one of said metals provided with an adherent metallic coating which comprises: forming a molten bath of a low-melting metal of the group consisting of lead, tin, cadmium, indium, zinc, and alloys of said metals with one another, covering the molten metal bath with a flux consisting essentially of an aluminum chloride-alkali metal halide mixture in which the relative proportion of aluminum chloride is between 50 mol percent and 80 mol percent and the amount of alkali metal chloride from the group consisting of lithium chloride, sodium chloride, and potassium chloride is between 50 mol percent and 20 mol percent and a minor amount of at least one other metal chloride, of the group consisting of zinc chloride and tin chloride; immersing the transition metal object in the flux and thence into the molten metal bath and withdrawing the coated metal from the metal bath and thereafter cold working the transition metal object, so coated.

4. The method of cold working a titanium object provided with an adherent metallic coating to facilitate cold working of the titanium which comprises: forming a molten bath of a low-melting metal of the group consisting of lead, tin, cadmium, indium, zinc, and alloys of said metals with one another and which work hardens more slowly than titanium, covering the molten metal with a flux consisting essentially of between about 50 mol percent of aluminum chloride and 80 mol percent

of aluminum chloride and between about 50 mol percent and 20 mol percent of at least one alkali metal chloride of the group consisting of lithium chloride, sodium chloride and potassium chloride, immersing the titanium object in the flux and thence into the molten metal bath and withdrawing the titanium object from the metal bath and thereafter cold working the coated titanium object.

5. The method of cold working a titanium object which comprises: immersing the object first in a molten flux consisting essentially of between 50 mol percent and 80 mol percent of aluminum chloride and between 50 mol percent and 20 mol percent of at least one alkali metal chloride from the group consisting of sodium chloride, potassium chloride, and lithium chloride and containing between 1% and 25% by weight of zinc chloride; then immersing the object in a molten metal bath of a low-melting metal of the group consisting of lead,

tin, cadium, indium, zinc, and alloys of said metals with one another, withdrawing the object and cold working the coated titanium object.

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