

1

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METAL SURFACE TREATMENT

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This invention relates to release coatings for metallic surfaces. More specifically, this invention provides for release surfaces on metals for materials which ordinarily adhere to metals when going through a change of state.

In specific embodiments of this invention, it provides for release surfaces on highly polished surfaces, such as casting drums, molds, and the like, which ordinarily adhere tenaciously to change-of-state materials.

In many industrial processes it is desirable to provide molds, casting surfaces, shaping surfaces, tools, and the like, which can be brought into contact with materials undergoing a change of state, and to be releasable from such materials after the change-of-state has been completed, or partially progressed to completion. Notably among these are the so-called casting surfaces, such as molds, casting drums, casting belts, and various tooling equipment, which ordinarily must be provided of metallic surfaces.

Another important use of metallic surfaces which must release from change-of-state materials is encountered in packaging machinery, converting equipment and the like, where waxes, polymers, solutions and the like are congealed in contact with metallic surfaces which must thereafter be released therefrom. A specific example of such an application is in the cooling belts of packaging equipment. Heretofore it has been a common practice to provide release agents, either built into such change-of-state compositions in such a manner that they will bloom to the surface upon conducting the change of state, or to provide intermediate release films on the casting surfaces, such as by the application of oils, silicones, fatty acid derivatives, soaps, and the like. Although these materials have in some instances provided the desirable release properties, inclusion of them in the composition itself is often undesirable due to the changes in properties of the compositions which occur, often precluding them from their intended use. Applications of intermediate films between the change-of-state material and the casting or tooling surface, although providing temporary release, is often quite fugitive and requires either continuous replenishment or the use of excessive amounts of material which often alter the surfaces of the cast or worked material.

I have now found that the application of perfluorocarboxylic acids to the surfaces of metallic objects can provide release of whatever composition is conducted through a change of state in contact therewith. Such perfluoro compounds may be perfluoroacetic acid, perfluoropropionic acid, perfluorobutyric acid, perfluorooctanoic acid, perfluorononanoic acid, perfluorodecanoic acid, perfluorobenzoic acid, perfluorotoluic acid, perfluorosuccinic acid, and the like. It is my belief that these materials react chemically with the metallic surfaces, as once they are deposited they are quite durable and are retained on the metallic surfaces unless abraded off.

In addition, the reaction of the perfluorocarboxylic acids, even on highly polished surfaces, does not appreciably alter the finish of the surfaces applied thereto. From experiments performed, it appears that only a molecular surface is required to obtain the desired release properties.

On the other hand, it has been found that application

2

of such materials as perfluoropolymers, notably teflon, results in a semi-permanent finish which is not chemically bonded and quite easily disturbed. Also, the application of metallic complexes, such as chromium complexes of the perfluorocarboxylic acids, does not result in a permanent release surface, and is not durable to the extent of the present invention.

As further illustration of the results obtained from my treatment, the following examples are typical. As seen from these examples, perfluorocarboxylic acids having 8 through 10 carbon atoms perform extremely well according to the present invention, and perfluoroalkanoic acids which have 8 through 10 carbon atoms are especially preferred for use in and in accord with the present invention.

EXAMPLE I

A wax mold measuring 4 x 4 x 1 inch was constructed of light mild steel plate, and chemically cleaned to obtain an oil free metallic surface, then thoroughly washed in water, and dried. To this surface was applied a 5% alcoholic solution of perfluorooctanoic acid, and the alcohol allowed to evaporate at room temperature. After standing for 16 hours at room temperature, the excess perfluorooctanoic acid was buffed off with a flannel cloth. When an adhesive microcrystalline wax composition was poured into the mold and allowed to congeal, the mold was found to break away very easily. A duplicate mold prepared in the same way, except that no perfluorooctanoic acid was applied, was found to adhere tenaciously to the microcrystalline wax composition and could not be broken away.

EXAMPLE II

A freshly chromium plated casting mold was dipped in an alcoholic solution of perfluorodecanoic acid, drained, and allowed to dry at room temperature. After standing for 16 hours at room temperature, the mold was heated to 200° F. for several hours, then cooled and buffed. An epoxy casting compound consisting of a bisphenol epichlorohydrin type epoxy (Shell 828) with the addition of ethylene diamine curing agent was poured into the mold and allowed to cure. The cast object was easily removed from the mold by light tapping. A duplicate mold, but with no treatment, would not release from the cast object, and the casting had to be drilled away.

EXAMPLE III

Paperboard was coated with a composition consisting of 40 parts of urea, 50 parts of pearl corn starch, and 10 parts of dialdehyde starch, made up to a gel in water at 200° F. The wet coating was brought in contact with a chromium plated cylindrical rotatable drum treated with perfluorooctanoic acid, and the coating dried in contact with the drum. When dried by heating the drum internally with steam, the board with its coating released easily from the drum with a mirror-like finish. A composition cast against an untreated chromium drum could not be peeled off and required abrasive means to clean the coating composition from the drum after drying.

Although I have shown in the examples the application of the perfluorocarboxylic acids from solution, other means and other solvents can be used for their application. In addition to the volatile alcohols, such as methanol, ethanol, propanol, isopropanol, butanol and the like, I may use hydrocarbons, such as petroleum ethers and naphthas, kerosene, benzene, toluene, cyclohexane, pentanes, heptanes and the like. I may also use chlorinated solvents, such as chloroform, carbon tetrachloride or ethylene dichloride.

Where intricate or contoured parts are treated, it is often desirable to vaporize the perfluorocarboxylic acid

to bring the vapors of such in condensation contact with the object, to obtain the necessary reaction with the metallic surface. Alternately, a continuous belt can be rotated over a vaporizer for the perfluorocarboxylic acid and sufficient material condensed thereon to effectively treat the surface.

In some instances it is desirable to combine the perfluorocarboxylic acid with a cleansing or abrasive compound, such as diatomaceous earth formed into a suitable paste with the addition of a solvent for the perfluorocarboxylic acid, such as water, alcohol or a glycol. Such compositions are especially desirable where it is desired to simultaneously cleanse or buff a metallic surface to a high finish and treat the surface for releasing characteristics.

It is also possible to combine the perfluorocarboxylic acid with some of the common etching solutions, such as phosphoric acid solutions, muriatic acid, and the like.

I have found the de-activation of even stainless steel surfaces is possible with the perfluorocarboxylic acids, although these metals have commonly been considered quite chemically resistant.

In addition to the materials specifically cited in the examples, any other compositions which normally adhere to metals after undergoing a change of state can be equally easily released from such treated surfaces as those shown in the examples. Such changes-of-state are characterized by the following:

(1) Drying of a liquid suspension or solution of a solid.

(2) Crystallization by cooling or evaporation of a solvent.

(3) Polymerization or condensation.

(4) Congealing of an amorphous material.

(5) Thermosetting or curing.

Although the perfluoro compounds have been specifically favored, it is possible to substitute part of the fluorine in the carboxylic acid up to 50%, by chlorine, without seriously detracting from the release properties. I have, however, found that it is desirable to have essentially all of the hydrocarbon hydrogens of the carboxylic acid replaced by halogen, as otherwise ultimate stability is not obtained, and partially substituted materials have a tendency to decompose, especially on continued heating.

Those skilled in the art will easily recognize that there are many other applications for the release surfaces herein disclosed than those already mentioned, and it is intended that this invention be limited only by the scope of the following claims.

1. The method of treating metal surfaces of casting apparatus which adhere to normally solid materials which have undergone a change-of-state in contact therewith comprising applying a perfluorocarboxylic acid to said metal surface in an amount to cover said surface with at least a continuous mono-molecular film of the perfluorocarboxylic acid to provide said metal with a

releasable surface for the normally solid material after a change-of-state has occurred.

2. A method of claim 1 wherein the perfluorocarboxylic acid is a perfluoroalkanoic acid which has 8 through 10 carbon atoms.

3. A metallic casting mold treated to form thereon at least a continuous mono-molecular film of a perfluorocarboxylic acid.

4. A cylindrical rotatable metallic casting surface treated to form thereon at least a continuous mono-molecular film of a perfluorocarboxylic acid.

5. A casting mold having a metallic casting surface for wax compositions treated to form thereon at least a continuous mono-molecular film of a perfluorocarboxylic acid.

6. The method of treating metal surfaces of casting apparatus to provide release properties thereon comprising applying a perfluorocarboxylic acid thereto in an amount to provide at least a monomolecular film of said acid, and causing said film to react with the metal surface.

7. The method of treating metal surfaces of casting apparatus to provide release properties consisting of applying an alcoholic solution of a perfluorocarboxylic acid thereto to form thereon at least a continuous mono-molecular film of said perfluorocarboxylic acid.

8. The method of treating metal surfaces of casting apparatus to provide them with release properties consisting of vaporizing a perfluorocarboxylic acid and condensing the vapors on said metallic surfaces to form thereon at least a continuous mono-molecular film of said perfluorocarboxylic acid.

9. A metal cleansing and buffing composition comprising a perfluorocarboxylic acid, a solvent for said acid and an abrasive agent in an amount sufficient to impart abrasive qualities to said composition.

10. A composition of claim 9 wherein the perfluorocarboxylic acid is a perfluoroalkanoic acid which has 8 through 10 carbon atoms.

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