A website to assist in process selection for product engineering

Introduction

This guide has been produced by the Institute of Metal Finishing for N-COAT 70, a project sponsored by the the TSB.

It is unusual for a manufactured article to perform satisfactorily without special concern for the demands to be made on its surface. In practice the bulk properties of one material are complemented by the surface properties to be obtained from another. Surface engineering is often not given its proper due in design and manufacture, with unfortunate outcomes; manufacturers are often not well - versed in the range of technologies available for optimising the performance of their products in the environment of their application. There are commercial and environmental consequences in choosing the most appropriate strategy for surface engineering in product design, not least in the surface technologist's contribution to energy and material conservation.

The guide is not intended to replace monographs on contemporary practice in the respective surface technologies (although links will be provided) -it is intended as an aid to engineers who seek a broad view of what can, currently, be done. Electrochemical treatments are versatile and economical so these take prime place. The overview indicates the nature of a variety of processes, the resulting surface properties and it gives illustrations of a breadth of applications. Links are provided to professional institutions, trade associations, to a commercial directory and to relevant publications, legislation and standards.

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N COAT- 70

Partners in this TSB supported project were:-

- The University of Nottingham
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- Anochrome Group
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- Ladbrook Manufacturing Ltd

Legislation. The finishing industry (including organic coatings) is strictly controlled. Legislation covers the safety of operatives, the factory environment, emissions, the safety of the products; and there are impending end of life requirements.

Standards. Surface coatings and their functionality are described in Standard Specifications. These standards can be obtained at www.bsi-global.com

PRINCIPAL TREATMENT TECHNIQUES

Electroplating and Electroless plating

Electroplating
Electroplating is the electrolytic deposition of an adhering (metal) layer on an electrode, aiming to give surface properties which differ from those of the base material. For instance, a very thin metal layer (thinner than a human hair) is often a very effective protection against corrosion. The process of electroplating is described briefly; examples of specific applications are also given there.

Electroplating processes using an external power source:

- Nickel Plating
- Zinc Plating
- Zinc Alloy Plating
- Chrome Plating
- Hard Chrome
- Noble / Precious Metal Plating
- Copper Plating
- Tin Plating
- Lead-Tin Plating
- Brush Plating
- Pulse Plating

Electroless processes:

- Chemical Nickel
- Chemical Copper
- Chemical Gold
- Composites

Processes combining electroplating and electroless plating:

- Plating on plastics
- Plating of Printed Circuits Boards
- Electroforming

Anodising

Aluminium and its alloys acquire tenacious and protective oxide layers in air. The formation, thickness and useful properties of these layers can be optimised by producing them anodically. Similar treatments are used for magnesium, titanium and zinc, but some 95% of all anodised material is aluminium.

Thermochemical Surface Treatments

These are processes where, at elevated temperatures, alloying elements are introduced in to the substrate surface. They are often refered to as Pack Processing.

Carburising
This is applied to steel. In a furnace treatment the surface of low-carbon steel is enriched with carbon by diffusion from a surrounding medium. This produces a hard surface on a substrate that remains tough. Carbonitriding involves the co-diffusion of nitrogen, resulting in a thinner surface layer.

Nitriding
In nitriding the furnace is filled with a nitrogen containing gas, the process may be applied to low alloyed steel and tool steel and to steels containing strong nitride formers (eg Mo, V, Al). Plasma nitriding involves lower furnace temperatures and shorter process time than carburising.

Boronising (Boriding)

Boronising involves the diffusion of the element from a surrounding medium to form a compound layer of metallic boride in the substrate surface. Temperatures of 800-1000ºC are applied for some hours and the technique is used to produce abrasion resistant surfaces on titanium-based and cobalt based alloys and on a restricted range of steels.

Laser Treatment

Laser processing is associated with very high rates of heat input. This is exploited in three types of surface treatment

- Laser transformation i.e. heat treatment
- Laser cladding
- Laser alloying

Sherardizing

A long -established process in which zinc is diffused to form a corrosion resistant layer especially on small instrument components made of iron and steel.

Enamelling

An enamel is a glassy layer, normally highly resistant to contaminants, wear and temperatures between -60ºC and 450ºC. Its application involves a furnace treatment. Enamels can be applied to a good range of metallic substrates.

Galvanizing

Hot dip galvanizing provides a robust alternative to zinc electroplate ("electrogalvanizing").

PVD and CVD

Physical vapour deposition (PVD) includes a range of processes in which vapour phase species, atoms or ions are derived from solid or liquid target materials by evaporation or sputtering. Coatings are formed from these species by simple condensation or after their activation, eg in a plasma. In a third PVD process the potential of the workpiece is adjusted to make it the cathode in a glow discharge. Chemical Vapour Deposition (CVD) is the deposition of coatings on heated surfaces from their chemical reaction with the ambient gases. This may be combined with radio-frequency glow discharge reaction enhancement.
Currently there is conciderable interest in the nature and application of diamond-like coatings

Sol-gel Processing

Mechanical Surface Treatments

Shot peening. Mechanical plating.

Cladding