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[54] **CONDUCTIVE PAINT FORMULATIONS WITH VERY LOW ELECTRICAL IMPEDANCE IN THE Z-DIRECTION CONTAINING A METAL CARBIDE**

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[51] **Int. Cl.**[2] **C23F 5/02**

[58] **Field of Search**.... 260/18 PN, 37 M, 29.6 MM, 260/29.7 M, 42.2 Z; 117/121, 126

[56] **References Cited**

UNITED STATES PATENTS

3,245,833	4/1966	Trevoy	252/516
3,380,935	4/1968	Ring	252/511
3,404,031	10/1968	Clayton et al.	117/226
3,563,916	2/1971	Takashina et al.	117/226
3,676,212	7/1972	Mishler	117/226
3,746,662	7/1973	Adelman	260/37
3,783,021	1/1974	York	117/226
3,788,997	1/1974	MacKenzie	252/516

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[57] **ABSTRACT**

One or more metallic carbides having the general structure MC in which M is selected from the group consisting of Titanium (Ti), Zirconium (Zr), Niobium (Nb), Hafnium (HF), Tantalum (Ta) and Tungsten (W) are mixed with standard paints to produce a paint which will provide a coating that has a very low electrical impedance in a direction orthogonal to the plane of the coating.

4 Claims, No Drawings

CONDUCTIVE PAINT FORMULATIONS WITH VERY LOW ELECTRICAL IMPEDANCE IN THE Z-DIRECTION CONTAINING A METAL CARBIDE

BACKGROUND OF THE INVENTION

The invention relates to compositions which can be used to provide a coating which has low electrical impedance. More particularly, the invention relates to compositions of paints which, when dry, will provide a coating which has a very low electrical impedance in a direction orthogonal to the plane of the coating (its "Z-direction").

When painting various surfaces such as, for example, the exterior panels of electronic data processing machines, it is often necessary or desirable to provide a means for establishing a path of low electrical impedance through the paint film. In the prior art, this is generally accomplished in either of two ways.

The first technique utilizes a conductive material which is attached through or around the painted substrate to provide a contact point on each side thereof. One example of this is the common use of so-called "rub strips" on, for example, the painted doors which cover various types of electrical equipment. An advantage of this approach is that it can be utilized when the substrate is a non-conducting material. One disadvantage is that the attachment of the conductive pieces generally requires an additional step in the manufacture and therefore involves increased labor cost. Another disadvantage is that the contact points established by this technique are generally rather small in relation to the size of the painted substrate; therefore requiring, in some situations, an extra amount of care in locating the electrical contacts.

When the substrate is, itself, an electrically conductive material, electrical through-connections can be achieved by painting it with an electrically conductive paint. Assuming that the substrate is to be painted anyway, no additional manufacturing step is required. Also, contact can be established over a relatively large area.

In accordance with one prior art technique, a conductive paint is made by adding, to any of a large number of known paint formulations a conductive filler. The two fillers most commonly used are silver and graphitic carbon. As between the two, a primary advantage of graphitic carbon is that is is significantly less expensive than silver. Also, its density is less than that of silver, and it therefore has a lesser tendency to settle out of the paint mixture. The primary advantage of silver is that it is a better conductor than graphitic carbon. When a substrate is painted with a commercially available conductive paint to produce a coating of approximately 1 to 2 mils thickness, resistivity in the Z-direction will typically be approximately 0.1 ohms for paint using a silver filler, and 600 ohms for paint using a carbon filler. (Although silver filled paints can have excellent conductivity, it should be noted that they are extremely expensive, costing as much as about $400 per gallon.)

Another filler which has been used is copper. However, copper has the disadvantage that it is subject to oxidation and the oxides are not conductive.

An object of this invention is to provide a paint having a very low electrical impedance in its z-direction.

A further object of the invention is to provide such a paint which will be economical to use when painting large surfaces.

Another object of the invention is to provide such a conductive paint which, when dry, will present an appearance that is esthetically pleasing.

Other objects of the invention are to provide such a conductive paint which, when dry, will have good characteristics of adhesion and impact resistance.

BRIEF DESCRIPTION OF THE INVENTION

In accordance with a preferred embodiment of the invention, the above and other objects are accomplished by providing a paint into which one or more metallic carbides are mixed. The metallic carbides have the general structure MC in which M is selected from the group consisting of Titanium (Ti), Zirconium (Zr), Niobium (Nb), Hafnium (HF), Tantalum (Ta), and Tungsten (W). Although carbide particles of a size up to about 44 microns may be used to advantage, the preferred range of particle size is approximately 1 to 5 microns. The concentration of carbide particles in the paint will preferably be in the range of 10 to 40% by dry weight.

The above and other objects, features and advantages of this invention will be apparent from the following description of preferred embodiments thereof.

DETAILED DESCRIPTION

Method of Testing

Before describing specific examples of paint formulations, it will be appropriate to describe the manner in which the various formulations were tested.

Coating formulations were prepared and applied to phosphatized steel panels such as those used by the paint industry for the evaluation of paints. These panels are approximately 3 inches wide × 5 inches long and 0.027 inches thick. The formulations described in the following examples were applied to the above mentioned steel panels and performance screening tests were used to determine the electrical contact impedance, the adhesion of the dried or baked film to the steel substrate, the impact resistance of the dried or baked film and its esthetic qualities.

The electrical contact impedance was measured by placing one lead of a D.C. ohmeter on the non-painted underside of the steel panel and placing the other lead from the ohmeter on the painted surface of the same panel. The resistance of the paint film can then be read directly from the ohmeter in ohms.

The adhesion of the coating to the steel panel is measured by a tape test. This test is performed by scoring six parallel lines about ⅛ inch apart and 1 inch long on the coated steel panel. The scorings must penetrate the coating to the steel substrate. This may be accomplished by using a pointed scalpel blade or sharp knife. Six more scorings are made similarly but at 90° to the first set of six scorings and superimposed upon the first set such that a "cross-hatch" pattern results in which there is a grid 25 squares, each approximately ⅛ × ⅛ inch. A piece of transparent cellophane tape 1 inch wide by about 6 inches long is firmly pressed down on the previously described grid and then pulled off briskly at an angle of approximately 90° to the steel panel. The adhesion test is said to have been "passed" if none of the paint is removed.

The impact test is a measure of the "toughness" and resiliency of a film. The test is performed using a commercially available impact tester. A known weight with a spherical head is dropped head down from a measured height. If the coating on the steel panel is fractured or in any way damaged it is said to have failed the test. The results are stated below in "inch-lbs."

Tests on the esthetic qualities of painted panels were made by subjective human observation and were primarily directed to the visual appearance and tactile feel of each painted panel.

EXAMPLES OF PAINT FORMULATIONS

Each of the following formulations was prepared and a steel panel was spray painted, then baked and tested as described above. In each case the coating of paint was approximately 1 to 2 mils thick. All proportions given below are by weight with the exception of the solvent, which is by volume. As is well known in the art, the amount of solvent which should be used for a given application will depend upon the manner in which the paint is to be applied (for example, by brushing or by spraying) and the viscosity desired. In each of the following examples, the solvent used was a mixture of (by volume) 20 parts toluene, 10 parts methyl ethyl ketone (MEK), 10 parts methyl isobutyl ketone (MIBK), 10 parts benzene and 25 parts ethyl acetate.

In each of the following examples, the impact resistance of the painted panel was measured as being in excess of 50 inch-lbs., and each painted panel passed the adhesion test.

EXAMPLE 1

50 parts ERL 2795 Epoxy resin
50 parts Versamid 115
40 parts TiC (325 mesh)
20 parts graphite (A-99)
60 parts solvent
viscosity 110 cp
impedance: less than 1 ohm

EXAMPLE 2

50 parts ERL 2795 Epoxy resin
50 parts Versamid 115
40 parts ZrC (1–5 micron)
20 parts graphite (A-99)
60 parts solvent
viscosity 90 cp
impedance: less than 1 ohm

EXAMPLE 3

50 parts ERL 2795 Epoxy resin
50 parts Versamid 115
40 parts TaC (1–5 micron)
20 parts graphite (A-99)
60 parts solvent
viscosity 110 cp
impedance: 500–1500 ohms

EXAMPLE 4

50 parts ERL 2795 Epoxy resin
50 parts Versamid 115
40 parts WC (1–5 micron)
20 parts graphite (A-99)
70 parts solvent
viscosity 110 cp
impedance: more than 5000 ohms

EXAMPLE 5

50 parts ERL 2795 Epoxy resin
50 parts Versamid 115
60 parts graphite (A-99)
100 parts solvent
viscosity 80 cp
impedance: 2200–2600 ohms

In the formulations described in the above five examples, the ERL 2795 epoxy resin is a product of the Union Carbide Corporation, the Versamid 115 is a product of General Mills Chemical Corporation and the graphite is a product of Asbury Graphite Mills.

It was found that the higher density carbides such as TaC and WC produce films having fairly high contact resistances. This is not due to the inherent resistivity of these carbides but rather to the fact that, because of their high densities, they settle more rapidly in the spray can: thus less of these carbides appear in the coating on the steel panel.

Example 5 shows that if graphite alone is used as a conductive filler, the contact resistance is about 2200–2600 ohms. The replacement of part of the graphite component in the formulation, with TiC (Example 1) or ZrC (Example 2) reduces the contact resistance by more than three orders of magnitude.

It was also found that, the 325 TiC used in Example 1, while it has good physical and electrical properties, is very gritty because of its coarseness (up to 44 microns). On the other hand, the 1–5 micron ZrC used in Example 2 provides a much smoother and esthetically acceptable texture.

In order to determine the effective range of loading of conductive metal carbides, the following examples were tested for electrical contact resistance when steel panels were sprayed and baked.

Example 6	Contact Resistance
Glidden conductive paint 1451–1	300–600 ohms
Example 7	Contact Resistance
Glidden 1451–1 conductive paint + 10% by day weight TiC 325 mesh	2–5 ohms
Example 8	Contact Resistance
Glidden 1451–1 conductive paint + 20% by day weight TiC 325 mesh	less than 1 ohm

The Glidden conductive paint cited in examples 6, 7, and 8 is a commercially available paint designated 1451-1 by The Glidden-Durkee Division of S.C.M. Corporation.

Two formulations similar to Example 1 were prepared in which the 325 mesh (up to 44 micron) TiC was replaced by 1–5 micron TiC (and by submicron TiC) and steel panels were spray painted as before. In both cases, the contact resistance was less than one ohm, the impact resistance was 120 inch-lbs. and the coating passed the adhesion test.

A commercially available water reducible conductive paint (made by The Glidden-Durkee Division, S.C.M. Corp. designated "Black Aqualure Conductive Coating") was modified by the addition of 1–5 micron TiC.

The additions by weight are tabulated below along with the electrical contact resistance.

	Contact Resistance (ohms)
"Black Aqualure" on steel panels	1800.
"Black Aqualure" with 12.5% of total non-volatile material TiC 1-5 micron added	1.
"Black Aqualure" with 17.5% of total non-volatile material TiC 1-5 micron added	1.
"Black Aqualure" with 22.2% of total non-volatile material TiC 1-5 micron added	0.5
"Black Aqualure" with 30% of total non-volatile material TiC 1-5 micron added	0.5

The intended ultimate use of the conductive coating governs the amount of MC which should be added to obtain a low impedance ground path.

For example, if there is a requirement that only small portions of a co-member be in contact with the painted surface, then the loading would necessarily need to be relatively high; i.e., 20-40% of MC. If however, there are massive contact areas such as a computer cover in contact with a computer frame, then 10-15% loading of MC would be adequate.

It should also be noted that the particle size range will dictate the texture of the dried or baked coating.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that the above and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A conductive paint formulation including:

10 to 40% by dry weight metallic carbide of the structure MC; wherein M is selected from the group consisting of titanium, zirconium, niobium, hafnium, tantalum and tungsten; and wherein the carbide particles are up to 44 microns in size.

2. The conductive paint formulation of claim **1** wherein: the concentration of carbide particles is between 10 and 30% by weight.

3. The conductive paint formulation of claim **2** wherein: the carbide particles consist essentially of particles within the range of size of 1 to 5 microns.

4. The conductive paint formulation of claim **3** wherein: the concentration of carbide particles is within the range of 10 to 15% by weight.

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