

HIGH TEMPERATURE, HIGH STRENGTH, COLORABLE MATERIALS FOR USE
WITH ELECTRONICS PROCESSING APPLICATIONS

Cross Reference to Related Applications

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This application claims priority to United States Provisional Patent Application Serial No. 60/407,749, filed September 3, 2002, which is hereby incorporated by reference herein.

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Background

Read/Write heads are electronic components that read information on magnetic media and/or write information onto magnetic media. Read/Write heads are used in many electronic devices and are commonly used in computers to read and write information to and from a computer's memory.

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Complicated assembly lines are typically used to make the Read/Write heads and to install them into electronic components. The Read/Write heads are stored and transported in special Read/Write head trays that facilitate shipping the heads and processing them at the assembly line. Most Read/Write head trays must prevent any electrostatic discharge (ESD). A tray is made ESD-safe by making the surface that the Read/Write head rests upon into a conductive surface. A conductive surface allows static electricity to dissipate so that a static charge can not build up on the surface.

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The Read/Write heads are dark-colored and small; in appearance, they resemble black peppercorns. The Read/Write heads are therefore difficult to see if the tray has a dark color. A dark color makes it difficult to verify that the read/write heads are present in the tray and to remove them from the tray, especially when machine vision is used.

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Read/Write head trays are conventionally from a material made by mixing a polymer with stainless steel. The stainless steel is sometimes referred to as a filler because it supplements the polymer's electrical properties by making the polymer into a conductive ESD safe material. The stainless steel is conductive and performs well at high temperatures, but, without pigment, creates a dark color. Stainless steel, however, is difficult to mix with a polymer to achieve a uniform distribution of stainless steel. Without a uniform distribution, the material is more prone to have small insulated spots that compromise the ESD-safe properties of the material. Further, the stainless steel has magnetic properties that could potentially damage the Read/Write heads. Moreover,

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materials made with stainless steel require high concentrations of pigments to color them, so that other properties of the material are compromised.

Summary of the Invention

5 These problems are solved by making Read/Write head trays that avoid the use of stainless steel. Instead of stainless steel, metal oxide fillers are used; consequently, the materials are colorable. The materials are colorable because they are light-colored and do not require high concentrations of pigments to color them. The materials for making the trays are preferably made with a high temperature, high strength polymer and a metal
10 oxide.

A preferred embodiment of the invention is a Read/Write head tray, at least a portion of the tray comprising an electrostatic discharge-safe surface for receiving a Read/Write head, with the surface being made of a mixture of at least one high temperature, high strength polymer and at least one metal oxide. The lightness of the
15 color of the materials may be measured and assigned an L value in the CIE L*a*b* index (see discussion, below), e.g., more than about 55.

Certain embodiments relate to a colored article for receiving electronic components that is a tray having a plurality of pockets that each have an electrostatic discharge-safe surface that comprises a mixture of at least one high temperature, high
20 strength polymer, at least one metal oxide, and at least one pigment. Certain embodiments relate to a set of trays for electronic component processing, the set having at least two subsets of trays wherein each tray has a plurality of pockets that each comprises an electrostatic discharge-safe surface, with each subset comprising a subset color distinct from the other subset colors. Certain embodiments relate to an article for receiving
25 electronic components, the article having a structure for contacting and supporting an electronic component, and with the structure comprising at least one electrostatic discharge-safe surface that comprises a mixture of at least one high temperature, high strength polymer and at least one metal oxide, wherein the surface has an L value of more than about 55 or 65.

30 Certain embodiments relate to an article for receiving electronic components, the article comprising a tray having a plurality of pockets, each pocket comprising at least one electrostatic discharge-safe surface that comprises a mixture of at least one high temperature, high strength polymer at least one metal oxide, and at least one pigment, wherein the surface has an L value of more than about 55 or 65. Certain embodiments

relate to a method of producing an article for electronic processing, the method comprising: molding a tray having a pocket that comprises an electrostatic discharge-safe surface that comprises a high temperature, high strength polymer and a conductive filler, wherein the surface comprises, an L value of at least about 55 or 65, and a resistivity in the range of 10^3 to 10^{14} ohms per square, wherein the surface is flatter than an average of about 0.1 or 0.015 inches per inch. Certain embodiments relate to a method of producing an article for electronic processing, the method comprising molding a tray having a pocket that comprises an electrostatic discharge-safe surface that comprises a high temperature, high strength polymer and a conductive filler, wherein the surface comprises, an L value of at least about 55 or 65, and a resistivity in the range of 10^3 to 10^{14} ohms per square, wherein the surface is flatter than an average of about 0.1 or 0.015 inches per inch.

Brief Description of the Figures

Figure 1 depicts the coordinate system for 1976 CIE $L^*a^*b^*$ Space and the L value for certain embodiments;

Figure 2 depicts a multipocketed tray for receiving electrical components;

Figure 3 depicts a cross-section of Figure 2 in a view as indicated by line 3-3 in Figure 2; and

Figure 4 depicts a plurality of the trays of Figure 2 in a stacked configuration.

Detailed Description of the Preferred Embodiments

A preferred embodiment of the invention is an ESD-safe Read/Write head tray that is light in color, is made of a high temperature, high strength polymer, and contains a metal oxide filler. The metal oxide filler preferably includes ceramics.

The lightness of the color of a material is objectively quantifiable using the Commission Internationale d'Eclairage $L^*a^*b^*$ color system (CIELab, see K. McLaren *The Development of the CIE 1976 ($L^*a^*b^*$) Uniform Colour-Space and Colour-Difference Formula*, J. Society of Dyers and Colourists, 92:338-341 (1976) and G.A. Agoston, *Color Theory and Its Application in Art and Design*, Hedelberg, 1979). As shown in Figure 1, the 1976 CIE $L^*a^*b^*$ system assigns every color a position on a three-coordinate axis. L is the measure of lightness, and has a value that ranges from 0 (black) to 100 (white). "L" is used herein for the 1976 CIE $L^*a^*b^*$ system: elsewhere, L^* may be used to refer to the same value described herein as "L". The a^* axis indicates the amount of red or green and the b^* axis indicates the amount of yellow or blue. Thus a value of 0

for both "a*" and "b*" indicates a balanced gray. Since the CIELab system is device-independent, it is a popular choice for computer imaging applications. The CIELab values are measurable using standardized tests that are familiar to those skilled in these arts, for example, by using a reflectance meter. For example, reflectance meters are manufactured
5 by Photovolt Instruments, Inc., Minneapolis, MN, (Photovolt Model 577 and by Minolta Corporation, Ramsey, NJ, (model Minolta CM 2002). Thus L is an objective, quantifiable, and reproducible measure of the lightness of any color.

Referring to Figure 1, certain embodiments of materials are set forth herein that provide for an L value that ranges from essentially 0 to about 100. For example, a very
10 dark, near black, color may be achieved by mixing polymers with carbon black to achieve an L value of close to 0. And white pigments, e.g., titanium oxides, can be added to achieve a near-white color close to 100. An example of an electrostatic discharge-safe material suitable for use as a support for electronic component processing having a light color is a polyetheretherketone mixed with about 54% by weight antimony-doped tin
15 oxide conductive material, which has an L value of 64.9, see "65" in Figure 1, as measured using a reflectance spectrophotometer with output programmed for the CIELab system. The other samples described herein have been visually determined to fall within the ranges as set forth, below.

In contrast to conventional processing methods in the relevant field of art, certain
20 embodiments set forth herein provide for materials having a high L value while maintaining suitable mechanical and electrostatic discharge-safe conductive properties. Moreover, certain embodiments retain moldability characteristics such as flatness. An aspect of certain of these embodiments is the use of metal oxides or ceramics to achieve the electrostatic discharge-safe and coloration properties. Another aspect of certain of
25 these embodiments is the use of high temperature, high strength polymers. Another aspect of certain of these embodiments is the use of isotropic flow particles. All ranges in the continuum from about 0 to about 100 are contemplated. Other embodiments achieve colorations having an L value of at least about 33, about 45, about 55, about 66, or about 80. Some embodiments have colorations that fall within an L value ranging from about 45
30 to about 100, from about 55 to about 99, and from about 66 to about 90. For example, a material with an L value of more than about 55 would mean that the material in question was closer to white on the CIELab scale than a material with an L value of about 55. As described herein, the conductive, polymeric, and conductive material concentrations are adjusted until a desired combination of mechanical, color, or conductive properties are

achieved for the contemplated application. Such adjustment could readily be performed by a person of ordinary skill in these arts after reading this disclosure.

A high temperature, high strength polymer is preferably one having high resistance to heat and chemicals. The polymer is preferably resistant to the chemical solvent N-methyl pyrildone, acetone, hexanone, and other aggressive polar solvents. A high temperature, high strength polymer has a glass transition temperature and/or melting point higher than about 150° C. Further, the high strength, high temperature polymer preferably has a stiffness of at least 2 GPa.

Examples of high temperature, high strength polymers are polyphenylene oxide, ionomer resin, nylon 6 resin, nylon 6,6 resin, aromatic polyamide resin, polycarbonate, polyacetal, polyphenylene sulfide (PPS), trimethylpentene resin, polyetheretherketone (PEEK), polyetherketone (PEK), polysulfone (PSF), tetrafluoroethylene/perfluoroalkoxyethylene copolymer (PFA), polyethersulfone (PES), high-temperature amorphous resin (HTA), polyallylsulfone (PASf), polyetherimide (PEI), liquid crystal polymer (LCP), polyvinylidene fluoride (PVDF), ethylene/tetrafluoroethylene copolymer (ETFE), tetrafluoroethylene/hexafluoropropylene copolymer (FEP), tetrafluoroethylene/hexafluoropropylene/perfluoroalkoxyethylene terpolymer (EPE), and the like. Mixtures, blends, and copolymers that include the polymers described herein may also be used. Especially preferable are PEK, PEEK, PES, PEI, PSF, PASf, PFA, FEP, HTA, LCP and the like. Examples of high temperature, high strength polymers are also given in, for example, U.S. Patent Nos. 5,240,753; 4,757,126; 4,816,556; 5,767,198, and patent applications EP 1 178 082 and PCT/US99/24295 (WO 00/34381) which are hereby incorporated herein by reference.

A metal oxide filler is a conductive material that includes metal oxide and can be added to a high temperature, high strength polymer to create an ESD safe material having a light color and sufficient mechanical properties for use as a Read/Write head tray. The metal oxides are preferably mixed with ceramics or coated upon ceramics e.g., metal oxide doped ceramics. Such fillers typically have a light color that allows them to be used to make a light colored material. Since they have a light color, other coloring agents may be added to impart a particular color to the material. Further, ceramics are durable, and metal oxide/ceramic combination materials typically have electroconductive properties that are independent of humidity. A ceramic is a material consisting of compounds of a metal combined with a non-metallic element. Ceramics include metal oxides.

Examples of suitable metal oxides are exemplified by aluminum borate, zinc oxide, basic magnesium sulfate, magnesium oxide, potassium titanate, magnesium borate, titanium diboride, tin oxide, and calcium sulfate. This list of oxides is exemplary and not intended to limit the scope of the invention. Further examples of fillers are provided in, for example, U.S. Patent Nos. 6,413,489; 6,329,058; 5,525,556; 5,599,511; 5,447,708; 6,413,489; 5,338,334; and 5,240,753, which are hereby incorporated herein by reference. In general, the metal oxides may be doped or coated with another metal as needed to impart or enhance conductivity.

A preferred filler is tin oxide, particularly antimony-doped tin oxide, for example, the family of products provided under the trade name Zelec® by Milliken Chemical Co. These products are small, roughly spherical-shaped, and light blue-gray to light green-gray in color. These colors allow for the creation of materials with a wide range of light colors, including white. Further, the antimony-doped tin oxide materials can be used to make transparent films and have the advantages of most ceramics, such as, non corrosiveness, resistance to acids, bases, oxidizers, high temperatures, and many solvents.

Another preferred class of fillers is whiskers, especially titanate whiskers, and more particularly potassium titanate and aluminum borate whiskers, which are described in, for example, U. S. Patent Nos. 5,942,205 and 5,240,753, which are hereby incorporated herein by reference. The term whisker refers to a single crystal filament having a cross-sectional area of up to about 8×10^{-5} of a square inch and a length of about at least 10 times the average diameter. Whiskers are typically free of flaws and are therefore much stronger than polycrystals that have a similar composition. Thus certain whisker fillers can improve the strength of a composite material as well as impart other properties such as improved rigidity, abrasion resistance, and electrostatic dissipation. A preferred class of whiskers are provided under the trade name DENTALL by Otsuma Chemical Co., Japan; these are ceramic whiskers coated with a thin layer of tin oxide.

The sizes and shapes of the fillers are not limited and may be e.g., whiskers, spheres, particles, fibers, or other shapes. The sizes of the fillers are not limited, but small particles such as whiskers or comparably sized spheres, or very small sizes are preferable. Technologies for making very small particles, e.g., using nanotechnology, may be employed.

Suitable metal oxide fillers may be disposed in a variety of configurations. For example, an inert core particle may be coated with a metal oxide. The metal oxide coating is thus extended by the inert particle to result in a less expensive product. Alternatively, a

hollow core may be used instead of an inert particle. Or, the size of the particles may be made smaller by omitting the core. Or, a ceramic may be doped with a metal oxide. Doped materials can be conductive while retaining the mechanical and coloring properties of the ceramic.

5 The metal oxide conductors should be disbursed in the material so that three-dimensional interconnecting networks of the conductors are formed. The networks serve as a circuit to drain static charges. The concentration of the metal oxide conductors is related to the ESD properties of the material. Very low concentrations of metal oxide conductors create a high surface resistivity. The resistivity drops slowly as the
10 concentration of metal oxide conductors is increased until a "percolation threshold" is reached when the metal oxide conductors begin touching each other and further increases in the metal oxide conductor concentration cause rapid drops in resistivity. Eventually, a ceramic concentration is reached wherein further increases in the metal oxide conductor concentration fails to create substantial drops in resistivity because the metal oxide
15 conductors have already formed an optimal number of networks. Typically, the addition of materials having less conductivity than the metal oxide conductors will result in increased surface resistivity. Thus, the addition of pigments can affect surface resistivity but compositions that have a desired resistivity can be made by adjusting the amounts of pigment and conductive filler.

20 There are numerous advantages to having a light-colored material for a Read/Write head tray. One advantage is that the Read/Write heads may be visualized. Another advantage is that the trays are colorable. Thus the color may be optimized to make the heads more easily visible. Or different types of Read/Write head trays may be made with different colors so that different models and applications of trays maybe easily recognized
25 by a user. Or various types or sizes of heads may be stored in trays of different colors so that shipping and use of the heads is efficient.

 Certain embodiments further incorporate pigments to achieve not only a desired L value, but also a particular color, e.g., red, green, blue, yellow, or combinations thereof. The pigments are added in a concentration suitable to achieve the desired color. The
30 desired coloration may be accomplished by adding pigments known to those skilled in these arts, and mixing them with conductive materials and polymers as described herein to achieve a desired color, conductivity, and mechanical characteristics. Examples of pigments include titanium dioxide, iron oxide, chromium oxide greens, iron blue, chrome green, aluminum sulfosilicate, cobalt aluminate, barium manganate, lead chromates,

cadmium sulfides and selenides. Carbon black may be used if a black color is desired or if the carbon black is used in concentrations that do not create an overly dark or black color. Colors that may be achieved with the use of pigments spans the spectrum of visible light, including white.

5 The filler(s) are preferably present in amounts sufficient to make the Read/Write head tray have a surface resistivity in the range of about 10^3 to about 10^{14} ohms per square, a range that imbues the surface with ESD-safe properties; more preferably the surface resistivity is in the range between about 10^4 to less than about 10^7 ohms per square. Further, the filler is preferably evenly distributed through the material so as to
10 avoid small insulated spots that compromise its ESD-safe properties. Further, the filler is preferably present in the concentration that avoids creating a black color in the material, and more preferably avoids creating a dark color in the material. The concentration of carbon black that is required to make an ESD safe material causes the material to be dark, and essentially black. Microchip trays are conventionally made with carbon black.

15 A material made of a polymer and a carbon filler is commonly used to make microchip trays for holding microchips. Prior art microchip trays, however, are not suitable for use as Read/Write head trays because the microchip trays are very dark colored due to the presence of the carbon filler. In a microchip tray, the Read/Write heads would be difficult to see because the Read/Write heads are small and dark and the
20 microchip tray is dark. As a result, it would be difficult to use such prior art trays in conjunction with Read/Write heads. Further, an acceptable chip tray surface resistivity is usually in the range of at least about 10^7 to 10^8 per square. In contrast, an acceptable read/write head tray surface resistivity is usually in the range of about 10^4 to less than about 10^7 ohms per square. Since a conductive material must be added to a polymer to
25 create an ESD safe material, and material with a resistivity of, e.g., 10^8 ohms per square has more filler than a material with a resistivity of, e.g., 10^4 ohms per square. Because of the uncertainties associated with increasing the amount of filler to high levels, approaches for making the ESD safe materials for computer chip trays can not be assumed to be transferable to read/write head trays. Moreover, materials used for use with computer chip
30 processing, for example wafer carriers, must have very low levels of extractable metal ions, but this is not a major concern for Read/Write head tray materials. Therefore technologies and approaches for making microchip trays are not applicable to making Read/Write head trays.

For these reasons, scientists making Read/Write head trays have developed technologies that are different from technologies for making computer chip trays. Instead of using a carbon filler, Read/Write head trays are conventionally made with a metallic filler such as stainless steel. The stainless steel is conductive, performs well at high temperatures, and does not create a dark color in the material. Since the material is not dark, the read/write heads may be readily visualized.

The inventors have unexpectedly found the surprising result that high temperature, high-strength polymers may be mixed with more than about 40% ceramics by weight to achieve an ESD safe material without losing desirable processing properties such as moldability and flowability and without losing desirable mechanical properties such as compressive and tensile strength and appropriate rigidity. This result is surprising because, although polymers may be mixed with moderate amounts of non polymeric materials without losing the desirable properties of the polymer in the final product, the addition of a large amount of non polymeric materials, i.e. more than about 40% by weight, would be expected to result in a final product with properties that did not resemble those of the polymer. Ceramics treated with, or doped with, metal oxides are preferable for creating ESD safe materials. Large amounts of such ceramics, however, are typically required to achieve the desired conductivity in the materials. The preferred concentration range of ceramics is between about 40% and about 75%, a more preferred concentration range is between about 45% percent and about 70%, and a yet more preferable range is between about 50% and about 60%.

Moreover, it is surprising that the addition of more than about 40% by weight metal oxides and/or ceramics to a high strength, high temperature polymer can result in materials having surfaces that are flat, and even more surprisingly, flatter than surfaces achieved with stainless steel. In fact, however, the use of metal oxides with a high strength, high temperature polymer results in a Read/Write head tray that is more flat than trays made with stainless steel. The term smooth may sometimes used to refer to a lack of warp, as was the case in the priority document of this application, but, for the sake of clarity, the term flat is adopted herein to denote a lack of warp. Warp is curvature that is sometimes undesirably introduced into a surface in a molding or other processing step. The term flat is thus not to be confounded with measures of roughness. Flatness is a desirable feature of Read/Write head trays. One possible reason for the unexpected flatness is that the metal oxides used in the flat surfaces had isotropic flow shapes. An isotropic flow shape is a shape that resists becoming oriented in any particular direction as

a result of forces created by a flowing fluid; in other words the flow characteristics of the particle are approximately the same in all directions. Thus a spherical particle has an isotropic flow shape because the particle does not become oriented in any particular direction when the particle is mixed in a flowing fluid. In contrast, a rod-shaped particle
5 does not have an isotropic flow shape because it tends to align its longest axis in the direction parallel to the direction of flow.

Many embodiments herein have been described in terms of Read/Write head trays because that is a preferred embodiment. However, these descriptions should also be understood as applying more generally to all types of trays that used in electronic
10 processing. Trays are used, for example, for microchips, computer components, and audio component processes, see also U.S. Patent No. 6,079,565 and U.S. Patent Serial No. 10/241,815, filed September 11, 2002, which are hereby incorporated herein by reference. Electronic processing includes those manufacturing processes that involve assembling components for the electronics industry. Trays are useful for such processes because the
15 components must be moved and/or stored in a fashion that is convenient and protects the components from contaminations and static discharges. A tray includes an electrostatic discharge-safe surface that receives and contacts an electronic component to thereby support it. Trays have a plurality of pockets, for example, as in Figures 2 and 3. The component is contained by the tray pocket, which may be, for example, an indentation, a
20 space surrounded by walls, posts, or protrusions, a groove, or other structure that limits the component's mobility while on the tray so that the tray can successfully be moved without dislodging the component from the tray. Trays are preferably stackable (Figure 4) and the stacks are preferably also stackable, e.g., on pallets, so as to facilitate processing.

A surface may comprise a material by molding the surface from the material. Thus
25 the materials in the surface are known if the material from which the surface is molded are known. Thus a surface may be assumed to resemble a material's bulk composition, even though it is appreciated that the very uppermost portions of a surface can have a composition that is distinct from the bulk of the material. Further, a surface may be determined to have an average flatness that is measurable in inches per inch.
30 Conventional flatness measurements or L value colorimetric measurements may be used that provide an average for a significant portion of the surface. Such measurements can thus be distinguished from measurements that provide an average for a very small portion of the surface, e.g., atomic force microscopy.

Referring to Figures 2-4, which depict a tray 100 having a plurality of pockets 180. The pockets 180 have bottom surfaces 120 that form sides 102 that contain objects on the bottom surfaces 120. The top surface 132 of tray 100 is continuous and defines separations between pockets 180. Outer edge 116 of top surface 132 is continuous with and perpendicular to upper tray side 122. Tray side 122 is perpendicular to lip 112. Lip 112 is perpendicular to lower tray side 114. Referring to Figure 4, trays 100 may be placed in a stacked configuration 101 without bottom tray surface 126 impinging on an electrical component, e.g., depicted by 208. Lip 112 acts as a stop for bottom tray surface 126.

Example 1

Prototype Read/Write head trays were prepared by molding them from a mixture of metal oxide ceramics with PEEK, as indicated in Table 1. The molding process was essentially the same as the process used for PEEK loaded with stainless steel, although the molding temperature was adjusted slightly downwards. The results of these experiments showed that Zelec® ECP 1410T was a preferable metal oxide ceramic for use in making light colored Read/Write head trays. Moreover, the high temperature, high-strength polymer could be loaded with more than 40 percent of the filler without compromising the mechanical properties needed for the Read/Write head trays. Furthermore, the surfaces for holding the Read/Write heads were surprisingly found to be flat, with a flatness that exceeded the flatness obtained with stainless steel fillers.

Table 1: Mixtures of metal oxide particles with high temperature, high-strength polymer.

Metal Oxide Filler	Loading (wt.%)	Color	Surface Resistivity (ohms/square)
Zelec® ECP 1410T	40	Light Gray	10^{13}
Zelec® ECP 1410T	60	Light Gray	10^5
Zelec® ECP 1410M	40	Dark Gray	10^5
Zelec® ECP 1410M	60	Did not work	--
Zelec® ECP 1410XC	40	Did not work	--
Zelec® ECP 1410XC	60	Did not work	--

Example 2

Prototype Read/Write head trays were prepared by molding them from a mixture PEEK and a metal oxide ceramic, as indicated in Table 2. The molding process was essentially the same as the process used for PEEK loaded with stainless steel, although the

molding temperature was adjusted slightly downwards. The results of these experiments showed that metal oxide ceramics could be used to make light colored Read/Write head trays that are ESD safe. Moreover, the high temperature, high-strength polymer could be loaded with more than 40 percent of the filler without compromising the mechanical properties needed for the Read/Write head trays.

Table 2: ESD properties of mixtures of metal oxide particles with high temperature, high-strength polymer.

Loading (percent%)	Surface Resistivity (ohms/square)	Static Dissipation (seconds)
40	10^{13}	100
47	10^{13}	120
52	10^7	0.03
54	10^5	0.03
60	10^5	0.03
60	10^5	0.03

Example 3

The properties of various compositions of PEEK mixed with metal oxide ceramics were compared, as indicated in Table 3, with a carbon fiber composition (18% wt.) and neat mixture of PEEK used as controls. Zelec® ECP 1410T (52%) was used as the metal oxide ceramic. The molding process was essentially the same as the process used for PEEK loaded with stainless steel, although the molding temperature was adjusted slightly downwards for most compositions. Shrinkage in the prototype head trays ranged from 0.008 to 0.013 in/in, an acceptable amount. Further, the prototypes were remarkably flat. The first prototype head tray model had a surface for receiving a Read/Write head having an average flatness of 0.004 +/- 0.001 in/in with a maximum of 0.007 in/in. a second prototype head tray model had a surface for receiving a Read/Write head that had an average flatness of 0.013 +/- 0.010 in/in with a maximum of 0.017 in/in.

The results of these experiments showed that metal oxides could be used to make light colored ESD safe Read/Write head trays with more than 40 percent by weight of metal oxide filler without compromising the mechanical properties needed for the head trays. Further, these experiments showed that unexpectedly flat surfaces could be obtained using a high temperature, high strength polymer in combination with a metal oxide, such as a metal oxide ceramic.

Table 3: Properties of various compounds of metal oxides and PEEK.

	Neat	Carbon Fiber (18 %)	Metal Oxide Ceramic (52 %)
Specific gravity	1.3	1.4	2.1
Melt temperature (°C.)	349	344	344
Modulus (GPa)	3.9	11	6.5
Break stress (MPa)	80	110	90
Break strain (%)	50	1.8	1.8

Example 4

5 The resin purity properties of various compositions of PEEK mixed with metal
oxide ceramics were compared, as indicated in Table 4, with a carbon fiber composition
(18% wt.) and neat mixture of PEEK used as controls. Zelec® ECP 1410T (52% wt) was
used as the metal oxide ceramic. The outgassing was measured by maintaining a sample
for 30 minutes and a 10 Tenax tube at 100°C and analyzing the released gasses using an
10 automated thermal desorption unit-gas chromatograph/mass spectrograph. Metals were
analyzed by placing plaques of the material in dilute nitric acid at 85° C for one-hour and
analyzing the extracted metals by ICP/MS inductively coupled plasma/mass spectrometer.
Anions were analyzed by exposing the material to dilute water at 85 degrees C. for one-
hour, followed by analyzing the water by ion chromatography. Table 5 shows the metals
15 recovered. Table 6 shows the anions recovered.

The results of these experiments showed that the metal oxide ceramics had
significantly more extractable metals than comparable materials formed using carbon
fiber. The amount of extracted metals, however, was adequate for use in a Read/Write
head tray.

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Table 4: Resin purity for various high temperature, high-strength compounds containing metal oxides.

	Neat PEEK	Carbon Fiber (18 %)	Metal Oxide Ceramic (52 %)
Outgassing (µg /gram)	0.60	0.62	0.50
Metals (ng/g)	6658	1057	2278
Anions (ng/g)	464	1104	419

Table 5: Metal levels of the compositions of Table 4.

	Metals present
Neat	Al, Ca, Co, Fe, K, Na, Ni, Pb, Sn, Ti
Carbon fiber (18 %)	B, Ca, Co, Fe, K, Mg, Na, Ni, Zn
Metal Oxide Ceramic (52 %)	Al, B, Ba, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Sn, Ti, Zn

Table 6: Anions of the various PEEK compounds of Table 4.

Anion (ng/g)	Neat	Carbon fiber (18 %)	Metal oxide (52%)
Fluoride	410	34	56
Chloride	BDL	400	280
Nitrate	BDL	130	14
Sulfate	10	For 70	60
Phosphate	44	BDL	900

BDL indicates below detection limits

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The embodiments described herein are provided as examples of the invention and are not intended to limit the scope and spirit of the invention. All patents and publications set forth in this application are hereby incorporated herein by reference.

10 An embodiment of the invention is a read/write head tray, at least a portion of the tray comprising an electrostatic discharge-safe surface for receiving a read/write head, with the surface being made of a mixture of at least one high temperature, high strength polymer and at least one metal oxide. Another embodiment of the invention is a tray made with a high temperature, high strength polymer chosen from the group consisting of polyphenylene sulfide, polyetherimide, polyarylktones, polyetherketone, 15 polyetheretherketone, polyetherketoneketone, and polyethersulfone. Another embodiment of the invention is a tray wherein the at least one metal oxide is chosen from the group consisting of aluminum borate, zinc oxide, basic magnesium sulfate, magnesium oxide, graphite, potassium titanate, magnesium borate, titanium diboride, tin oxide, calcium sulfate, and antimony doped tin oxide. Another embodiment of the invention is a tray 20 wherein the metal oxide is disposed in particles, and the particles are present in the mixture at a concentration of at least 40 percent by weight, or at a concentration of between 50 and 70 percent. The particles may also further comprise a ceramic. Further the metal oxide may be disposed in a whisker. Moreover, the whiskers may be chosen from the group consisting of whiskers made of potassium titanate and aluminum borate.

Another embodiment of the invention is a filler comprising metal oxide disposed in a particle, wherein the particle has an isotropic flow shape.

Claims

1. A colored article for receiving electronic components, the article comprising:
a colored tray having a plurality of pockets that each have an electrostatic discharge-safe surface that comprises a mixture of at least one high temperature, high strength polymer, at least one metal oxide, and at least one pigment.
2. The article of claim 1 wherein the high temperature, high strength polymer comprises a member of the group consisting of polyphenylene sulfide, polyetherimide, polyarylketones, polyetherketone, polyetheretherketone, polyetherketoneketone, polyethersulfone.
3. The article of claim 1 wherein the metal oxide is present at a concentration of about 40% to about 75% by weight.
4. The article of claim 3 wherein the surface has a L value of at least about 55.
5. The article of claim 1 wherein the metal oxide is present at a concentration of about 50% to about 60% by weight.
6. The article of claim 1 wherein the surface has a L value of at least about 55.
7. The article of claim 1 wherein the surface has a L value of at least about 65.
8. The article of claim 1 wherein at least a portion of the surface comprises a bottom of the pocket, with the bottom being flatter than an average of about 0.1 inches per inch.
9. The article of claim 1 wherein at least a portion of the surface comprises a bottom of the pocket, with the bottom being flatter than an average of about 0.015 inches per inch.
10. The article of claim 1 wherein the high temperature, high strength polymer comprises a member of the group consisting of polyphenylene oxide, ionomer resin, nylon 6 resin, nylon 6,6 resin, aromatic polyamide resin, polycarbonate, polyacetal, trimethylpentene resin, polysulfone, tetrafluoroethylene/perfluoroalkoxyethylene

copolymer, high-temperature amorphous resin, polyallylsulfone, liquid crystal polymer, polyvinylidene fluoride, ethylene/tetrafluoroethylene copolymer, tetrafluoroethylene/hexafluoropropylene copolymer, and tetrafluoroethylene/hexafluoropropylene/perfluoroalkoxyethylene terpolymer.

11. The article of claim 1 wherein the at least one metal oxide comprises a member of the group consisting of aluminum borate, zinc oxide, basic magnesium sulfate, magnesium oxide, graphite, potassium titanate, magnesium borate, titanium diboride, tin oxide, and calcium sulfate.
12. The article of claim 1 wherein the at least one metal oxide comprises antimony doped tin oxide.
13. The article of claim 1 wherein the at least one metal oxide comprises a metal oxide doped ceramic.
14. The article of claim 1 wherein the at least one metal oxide is disposed in particles.
15. The article of claim 14 wherein the particles are present in the mixture at a concentration of at least 40 percent by weight.
16. The article of claim 15 wherein the surface has an L value of at least about 55.
17. The article of claim 14 wherein the metal oxide is present at a concentration between about 50 and about 70 percent by weight.
18. The article of claim 14 wherein the particles comprise a ceramic.
19. The article of claim 1 wherein at least a portion of the metal oxide comprises a whisker.
20. The article of claim 19 wherein the whisker comprises a material in the group consisting of titanate, potassium titanate, and aluminum borate.

21. The article of claim 14 wherein the particles comprise an isotropic flow shape.
22. The article of claim 1 wherein the pigment comprises a member of the group consisting of titanium dioxide, iron oxide, chromium oxide greens, iron blue, chrome green, aluminum sulfosilicate, cobalt aluminate, barium manganate, lead chromates, cadmium sulfides and selenides.
23. The article of claim 1 wherein the at least one metal oxide is the at least one pigment.
24. The article of claim 1 wherein the surface comprises a resistivity in the range of 10^3 to 10^{14} ohms per square.
25. The article of claim 1 wherein the surface comprises a resistivity in the range of 10^4 to about 10^7 ohms per square.
26. A set of colored trays for electronic component processing, the set comprising:
at least two subsets of colored trays wherein each colored tray has a plurality of pockets that each comprises an electrostatic discharge-safe surface, with each subset comprising a subset color distinct from the other subset colors, wherein the surfaces comprise a high temperature, high strength polymer, a metal oxide, and a pigment.
27. The set of trays of claim 25 wherein each subset of trays corresponds to a different model of tray.
28. The set of trays of claim 26 wherein each subset of trays corresponds to a type of component in the pockets of the trays.
29. The set of claim 26 wherein the pockets are flatter than an average of about 0.1 inches per inch.

30. The set of claim 26 wherein the pockets are flatter than an average of about 0.015 inches per inch.
31. The set of claim 26 wherein the surface has an L value of at least about 55.
32. The set of claim 26 wherein the at least one metal oxide is chosen from the group consisting of aluminum borate, zinc oxide, basic magnesium sulfate, magnesium oxide, graphite, potassium titanate, magnesium borate, titanium diboride, tin oxide, calcium sulfate, and antimony doped tin oxide.
33. The set of claim 26 wherein the at least one metal oxide is present at a concentration between 50 and 70 percent by weight.
34. An article for receiving electronic components, the article comprising:
a structure for contacting and supporting an electronic component, the structure comprising at least one electrostatic discharge-safe surface that comprises a mixture of at least one high temperature, high strength polymer and at least one metal oxide, wherein the surface has an L value of more than about 55.
35. The article of claim 34 wherein the surface comprises a bottom of a pocket.
36. The article of claim 34 wherein the surface is flatter than an average of about 0.1 inches per inch.
37. The article of claim 34 wherein the polymer has a stiffness of at least about 1 GPa and a glass transition temperature or melting point higher than about 150° C.
38. The article of claim 34 wherein the metal oxide is present at a concentration of about 40% to about 75% by weight.
39. The article of claim 34 wherein the at least one metal oxide comprises a member of the group consisting of aluminum borate, zinc oxide, basic magnesium sulfate, magnesium

oxide, graphite, potassium titanate, magnesium borate, titanium diboride, tin oxide, calcium sulfate, and antimony doped tin oxide.

40. The article of claim 34 wherein the surface further comprises a pigment.
41. A colored article for receiving electronic components, the article comprising:
a colored tray comprising a plurality of pockets, each pocket comprising at least one electrostatic discharge-safe surface that comprises a mixture of at least one high temperature, high strength polymer, at least one metal oxide, and at least one pigment, wherein the surface has an L value of more than about 55.
42. The article of claim 41 wherein the surface is flatter than an average of about 0.1 inches per inch.
43. The article of claim 41 wherein the polymer has a stiffness of at least about 1 GPa and a glass transition temperature or melting point higher than about 150° C.
44. The article of claim 41 wherein the at least one metal oxide is present at a concentration of about 40% to about 75% by weight.
45. The article of claim 41 wherein the at least one metal oxide is present at a concentration of about 40% to about 75% by weight.
46. The article of claim 34 wherein the at least one metal oxide comprises a member of the group consisting of aluminum borate, zinc oxide, basic magnesium sulfate, magnesium oxide, graphite, potassium titanate, magnesium borate, titanium diboride, tin oxide, calcium sulfate, and antimony doped tin oxide.
47. The article of claim 41 wherein the pigment is the metal oxide.
48. A method for processing electronic components, the method comprising placing an electronic component on an electrostatic discharge-safe surface of a colored tray that comprises a plurality of pockets, with the surface being a bottom of a pocket and

comprising a mixture of at least one high temperature, high strength polymer, at least one metal oxide, and at least one pigment.

49. The method of claim 48 wherein the at least one the high temperature, high strength polymer comprises a member of the group consisting of polyphenylene sulfide, polyetherimide, polyarylketones, polyetherketone, polyetheretherketone, polyetherketoneketone, polyethersulfone.

50. The method of claim 48 wherein the at least one metal oxide is present at a concentration is about 40% to about 75% by weight.

51. The method of claim 48 wherein the surface has a L value of at least about 55.

52. The method of claim 48 wherein at least a portion of the surface is flatter than an average of about 0.1 inches per inch.

53. The method of claim 48 wherein the at least one metal oxides comprises particles are present in the mixture at a concentration of at least 40 percent by weight.

54. The method of claim 48 wherein at least a portion of the at least one metal oxide comprises a whisker.

55. The method of claim 48 wherein the at least one metal oxide comprises particles that comprise an isotropic flow shape.

56. The method of claim 48 wherein the at least one pigment is the at least one metal oxide.

57. The method of claim 48 wherein the surface comprises a resistivity in the range of 10^3 to 10^{14} ohms per square.

58. The method of claim 48 wherein the colored tray is a read/write head tray.

59. The method of claim 48 wherein the at least one pigment comprises a member of the group consisting of titanium dioxide, iron oxide, chromium oxide greens, iron blue, chrome green, aluminum sulfosilicate, cobalt aluminate, barium manganate, lead chromates, cadmium sulfides and selenides.

60. A method of producing an article for electronic processing, the method comprising:

molding a tray having a plurality of pockets that each comprise an electrostatic discharge-safe surface that comprises a high temperature, high strength polymer and a conductive filler, an L value of at least about 55, and a resistivity in the range of 10^3 to 10^{14} ohms per square, wherein the surface is flatter than an average of about 0.1 inches per inch.

61. The method of claim 60 wherein the polymer has a glass transition temperature or melting point higher than about 150° C and a stiffness of at least about 1 GPa.

62. The method of claim 60 wherein the conductive filler is a metal oxide present in a concentration of about 40% to about 75% by weight.

63. The method of claim 60 wherein the article is a read/write head tray.