

[54] **METHOD OF PRODUCING ELECTRICAL FUSE ELEMENTS**

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[58] **Field of Search**..... 29/623, 620, 621; 117/212, 213, 215, 229, 119, 220

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[57] **ABSTRACT**

The present disclosure relates to a method of producing electrical fuse elements by single or multiple vacuum deposition of one or several electrically conductive elements or compounds onto substrates of insulating materials in forming thereon resistance paths having predetermined geometrical configurations and a predetermined electrical conductivity and/or magnetic, optical, radioactive, photoconductive or semiconductive properties.

14 Claims, No Drawings

METHOD OF PRODUCING ELECTRICAL FUSE ELEMENTS

The present invention relates to a method of producing electrical fuse elements.

Surprisingly it has now been discovered that electrical fuse elements adapted to be externally connected in various electrical apparatus may be produced economically according to the present invention by vacuum deposition of one element and/or several electrically conductive elements and/or compounds onto substrates of insulating materials, and forming thereon resistance paths of predetermined geometrical dimensions (fuse paths) having a suitable electrical conductivity and a suitable temperature coefficient of the resistor element.

The deposition substance consists of a physically neutral base substance such as quartz and/or silicon monoxide and/or a metal boride and/or a metal silicide and physically active doping elements which are vacuum deposited together with the base substance. Whereas the physically neutral base substance is preferably quartz, silicon monoxide, tungsten boride or tungsten silicide, the physically active elements or respectively compounds are selected to exhibit for example a low or a high electrical conductivity or magnetic, optical, radioactive, photoconductive or semiconductive properties. One or several physically active elements may be deposited together with the base substance.

For producing coatings having electrical properties may be used one of the elements Ag, Al, Au, Be, Cd, Co, Cu, Fe, In, Mg, Mn, Mo, Nb, Nd, Ni, Os, Pb, Pd, Pr, Pt, Rb, Re, Rh, Ru, Sb, Sc, Sm, Sn, Sr, Ta, Th, Ti, Tl, Tm, V, W, Y, Yb, Zn, Zr, oxygen compounds of such elements, oxygen compounds of such elements whereby the oxygen compound of the element that is condensed upon the substrate is of a lower oxidation stage than the base material, as well as alloys of such elements.

Coatings having magnetic properties will be obtained when for the active elements will be used Co, Fe, Ni as well as oxygen compounds of such elements or alloys thereof.

In producing coatings having optical properties the active components used are preferably the elements of the group of the rare earths, the group of the rare earths and the oxygen compounds thereof, the group of the rare earths and compounds thereof with group VII of the periodic table, the elements Ag, Al, Au, Be, Co, Cu, Fe, In, Mg, Mn, Mo, Nd, Ni, Pb, Sb, Ta, Th, Ti, W, Y, Zn, Zr, oxygen compounds of such elements and compounds thereof with group VII of the periodic table and alloys of such elements.

Coatings having photoconductive properties may be obtained by using as the active component one of the elements Ag, Al, As, Au, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, In, K, La, Li, Mg, Mn, Mo, Pb, Pd, Rb, Re, Rh, Sb, Se, Si, Sn, Sr, Ta, Te, Th, Ti, Tl, V, W, Zn, Zr as well as compounds of such elements with an element of group VII of the periodic table.

When using as the active component one of the elements Ac, Am, At, Bc, Cf, Cm, Es, Fm, Fr, Md, Np, No, Pu, Po, Pm, Pa, Ra, Rn, Tc, a coating having radioactive properties may be obtained.

When the active component used is one of the elements germanium or silicon or one of the (II) or (IV)

compounds of germanium or one of the (III) or (V) compounds of silicon, the thus obtained coatings will have semiconductive properties.

In accordance with another feature of the invention soldering pads or mechanical contact pads such as for plug connectors may be deposited together with the fuse paths at either end thereof onto the substrate.

The fuse paths are vacuum deposited in suitable geometrical dimensions onto substrates of glass, ceramics, plastics, hardboard, fiberboard or any other suitable insulating material. Several fuse paths which may have different electrical fuse characteristics and may be provided or not with electrical contacts for separate circuits may be vacuum deposited onto one and the same substrate.

The insulating material may consist of a dielectric substrate which is also produced by vacuum deposition and has a thickness up to 5 microns. The desired resistance paths and the contacts will then be vacuum deposited onto such insulating material.

The present invention moreover proposes a method of producing very quick-acting fuse elements wherein a chemically soluble layer such a laquer layer is applied to a suitable carrier material such as glass and then a dielectric inorganic coating is vacuum deposited onto the first layer. Subsequently the resistance paths and the contacts are vacuum deposited and the carrier material with the first layer and the thereon deposited coatings is immersed in a solvent adapted to dissolve the first layer. In this manner, the glass carrier is separated from the dielectric sheet substrate with the resistance paths formed thereon. Then the dielectric sheet is divided by cutting the sheet parallel to the resistance paths. For a minimum thermal capacity of the support material, the dielectric support material consists of a vacuum deposited coating having a thickness of preferably 1 to 5 microns whereby the fuse paths are vacuum deposited onto the dielectric substrate. The fuse paths obtained in this manner are highly flexible and may be electrically connected intermediate two stationary terminals and have a very small mass.

Additional dielectric coatings for providing an electrical, mechanical and chemical protection for the resistance paths may be vacuum deposited onto the fuse paths which have been vacuum deposited onto the substrates. Several fuse paths for separate electrical circuits and having different electrical fuse characteristics may be vacuum deposited side by side or in the form of several layers one on top of the other. The thus produced fuse paths may be activated by a mechanical and/or an automatic switch. Two or multiple vacuum deposited and mutually independent fuse paths may be utilized so that when one fuse path or fuse element burns through the whole second fuse circuitry is actuated by mechanical or electrical commutation. Fuse element arrangements of this type are particularly suitable in automobile assembly wherein a fuse box may be used for various types of automobiles by correspondingly arranging the contacts.

I claim:

1. A method of producing electrical fuse elements having a predetermined pattern of resistance paths of predetermined conductivity and predetermined temperature coefficient, which comprises vacuum depositing on a carrier substrate of insulating material, a material having three components, to wit:

- a. a substance exhibiting current-conducting characteristics;
- b. a physically neutral base substance selected from the group consisting of silicon monoxide, metal boride, metal silicide and quartz; and
- c. a physically active doping substance having optical, magnetic, photoelectrical or radioactive characteristics, said material being vacuum deposited on selected areas of said substrate so as to form said predetermined pattern of resistance paths.

2. A method as claimed in claim 1, wherein subsequently a substance having dielectric characteristics is vacuum deposited on said pattern of resistance paths thereby to form a protective insulating coating on said resistance paths.

3. A method according to claim 1 wherein soldering or mechanical contact pads are deposited onto the substrate together with the resistance paths at either end thereof.

4. A method according to claim 1 wherein the substrate is a dielectric substrate material having a thickness up to about 5 microns onto which the resistance paths are vacuum deposited.

5. A method according to claim 1 wherein as active doping substance (c) are used elements or compounds having a low or a high electrical conductivity and being selected from the group consisting of Ag, Al, Au, Be, Cd, Co, Cu, Fe, In, Mg, Mn, Mo, Nb, Nd, Ni, Os, Pb, Pd, Pr, Pt, Rb, Re, Rh, Ru, Sb, Sc, Sm, Sn, Sr, Ta, Th, Ti, Tl, Tm, V, W, Y, Yb, Zn, Zr alloys of said elements and oxygen compounds of said elements, provided, if oxygen compounds of said elements are used, the oxygen compound of the element that is deposited upon the substrate is of a lower oxidation stage than the original oxygen compound.

6. A method according to claim 1 wherein as active doping substance (c) are used elements or compounds exhibiting optical properties and being selected from the group consisting of (a) the rare earths, (b) compounds of the rare earths and oxygen, (c) compounds of the rare earths and group VII elements of the periodic table, and (d) Ag, Al, Au, Be, Co, Cu, Fe, In, Mg, Mn, Mo, Nd, Ni, Pb, Sb, Ta, Th, Ti, W, Y, Zn, Zr, as well as oxygen compounds of said elements (d) and compounds of said elements (d) with group VII elements of the periodic table, and alloys of said elements (d).

7. A method according to claim 1 wherein as active doping substance (c) are used elements or compounds having magnetic properties and being selected from the group consisting of Co, Fe, Ni, oxygen compounds of said elements and alloys of said elements.

8. A method according to claim 1 wherein as the ac-

tive doping substance (c) are used elements or compounds having photoconductive properties and being selected from the group consisting of Ag, Al, As, Au, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, In, K, La, Li, Mg, Mn, Mo, Pb, Pd, Rb, Re, Rh, Sb, Se, Si, Sn, Sr, Ta, Te, Th, Ti, Tl, V, W, Zn, Zr and compounds of said elements with an element of group VIII of the periodic table.

9. A method according to claim 1 wherein as active doping substance (c) are used elements or compounds having radioactive properties and being selected from the group consisting of Ac, Am, At, Bc, Cf, Cm, Es, Fm, Fr, Md, Np, No, Pu, Po, Pm, Pa, Ra, Rn and Tc.

10. A method according to claim 1 wherein as active doping substance (c) are used elements or compounds having semiconductive properties and being selected from the group consisting of germanium, silicon and compounds thereof.

11. A method of producing electrical fuse elements having a predetermined pattern of resistance paths of predetermined conductivity and predetermined temperature coefficient, which comprises:

- a. applying on a substrate a layer of a material which is soluble in an organic solvent;
- b. vacuum depositing on the layer of (a) a dielectric layer of inorganic material;
- c. thereafter vacuum depositing a predetermined pattern of resistance paths of an electrically conductive material on said dielectric layer of (b); and
- d. dissolving layer (a) with an organic solvent, whereby a structure composed of the dielectric layer (b) and said pattern of resistance paths vacuum deposited thereon is obtained.

12. A method as claimed in claim 11, wherein said layer (a) is a lacquer layer.

13. A method as claimed in claim 11, wherein said electrically conductive material (c) has three components, to wit:

- a. a substance exhibiting current-conducting characteristics;
- b. a physically neutral base substance selected from the group consisting of silicon monoxide, metal boride, metal silicide and quartz; and
- c. a physically active doping substance having optical, magnetic, photoelectrical or radioactive characteristics.

14. A method as claimed in claim 11, wherein subsequently a substance having dielectric characteristics is vacuum deposited on said pattern of resistance paths thereby to form a protective insulating coating on said resistance paths.

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