

- [54] **PYROTECHNIC ERADICATION OF MICROCIRCUITS**
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- [73] Assignee: **The United States of America as represented by the Secretary of the Navy**
- [22] Filed: **Nov. 2, 1970**
- [21] Appl. No.: **90,209**
- [52] U.S. Cl.**307/202**, 102/28 R, 102/70.2 R, 149/37, 149/109, 174/68.5, 307/298, 307/299, 307/303, 317/101 CC, 338/308
- [51] Int. Cl.**C06b 19/02**, H03k 17/84, H05k 1/18
- [58] Field of Search ..317/80, 101 CE, 258; 307/298, 307/202, 299, 303; 174/68.5; 109/33; 149/37

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[57] **ABSTRACT**

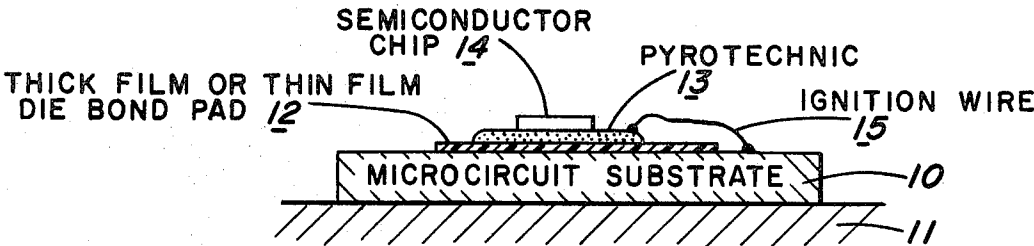
An anticompromise pyrotechnic eradication thin film circuit module having thin films of perfluoropolymer and metal thereon in sufficient quantity to produce a pyrotechnic reaction to cause heat of fusion of the metals of the thin film circuit to destroy the circuit beyond recognition and repair.

[56] **References Cited**

UNITED STATES PATENTS

3,666,967 5/1972 Keister et al.307/202

5 Claims, 4 Drawing Figures



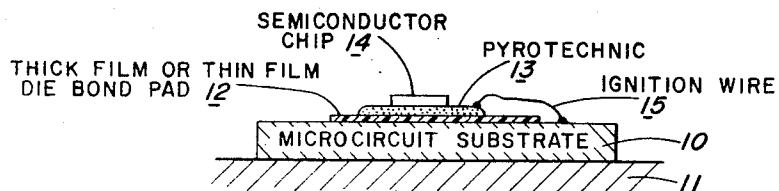


FIG. 1

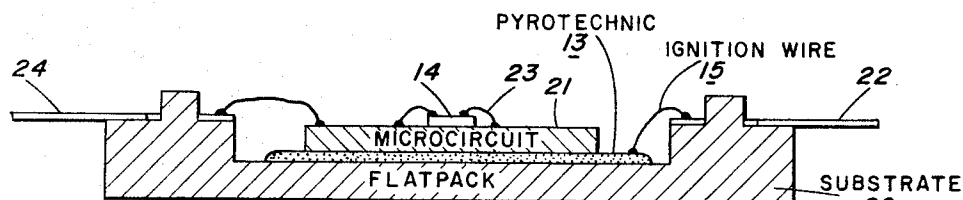


FIG. 2

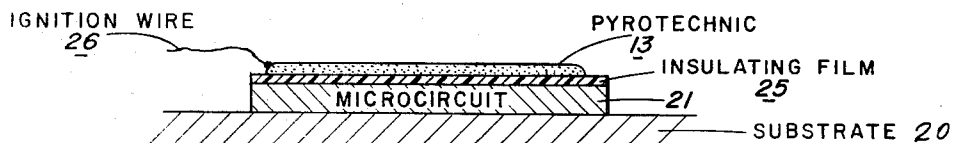


FIG. 3

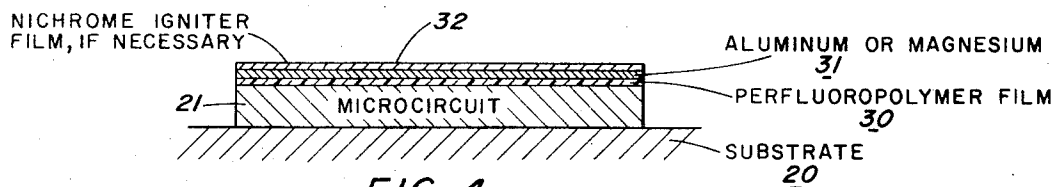


FIG. 4

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PYROTECHNIC ERADICATION OF MICROCIRCUITS

BACKGROUND OF THE INVENTION

This invention relates to anticompromise circuits and more particularly to self-destruct circuit modules in which the destructive materials are mixtures or deposited film layers of perfluoropolymer and metal to produce pyrotechnic reaction.

Circuit destruction devices are known that use explosives or combustible materials packaged to be placed adjacent the circuit components to be destroyed. The explosion or fire created thereby was intended to damage or destroy the circuits beyond recognition or repair. The disadvantages of such destruct systems were that the destruction was usually local and the package was too bulky to position at strategic places of the circuit where space was at a premium. One known circuit destruct utilizes an oxidant in a combustible thin film layer over or under a thin film circuit to destroy the circuit when a pyrotechnic package placed somewhere on the circuit module is ignited. Another known method of circuit destruction lies in the use of acids which can be set free to etch away the thin film circuit.

SUMMARY OF THE INVENTION

In the present invention a self-destruct mixture or combination of thin film materials are made compatible with, and become an integral part of, the thin film circuit on a module. These self-destruct materials are taken from a group of perfluoropolymers, having as high a fluorine content as possible, and metals which may best be used for this purpose in powdered form. While there are many perfluoropolymers and metals to choose from, one good example may be polyfluoroethylene, known as Teflon, and magnesium or aluminum powdered metals. It is accordingly a general object of this invention to provide a pyrotechnic destruct film coating for thin film circuit modules to destroy the circuit beyond recognition, use, or reconstruction at will to prevent circuit compromise with enemy forces.

DESCRIPTION OF THE DRAWING

These and other objects and the attendant advantages, features, and uses will become more apparent to those skilled in the art as a more detailed description proceeds when considered along with the accompanying drawing, in which:

FIG. 1 is a cross section of a circuit module in which the pyrotechnic material is incorporated as a die bond material between a semiconductor chip and the microcircuit substrate;

FIG. 2 is a cross-sectional view of a thin film flat pack in which the pyrotechnic material is used as the bonding agent between the microcircuit and the substrate;

FIG. 3 is a cross-sectional view of a thin film circuit module with the pyrotechnic material on top of the microcircuit; and

FIG. 4 is a cross section of a thin film circuit module in which the pyrotechnic material is deposited directly on the microcircuit as alternate thin film layers.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to FIG. 1, a microcircuit substrate 10 is mounted on a substrate board or support 11. A microcircuit thin film or thick film 12 is deposited on the microcircuit substrate 10 with a pyrotechnic material 13 of perfluoropolymer and metal deposited or pasted on top to support a semiconductor element such as a semiconductor chip 14. A separate circuit in the microcircuit coupled through appropriate switch means to a voltage source is connected by ignition wire 15 to the pyrotechnic film to produce pyrotechnic reaction and destruction of the microcircuit whenever it is desirable to do so.

Referring to FIG. 2, like reference characters referring to like parts, a flatpack substrate 20 has the pyrotechnic material 13 used to bond a thin film or thick film microcircuit 21 thereon with the ignition wire 15 connecting it with terminals 22 on substrate 20. A semiconductor chip 14 may also rest on the top of the microcircuit film 21 and be electrically connected by connecting wires 23. The microcircuit film 21 is connected to terminals, one of which is illustrated in this figure by the reference character 24. The pyrotechnic material 13 of perfluoropolymer and powdered metal will destroy the microcircuit film 21 beyond recognition or use.

Referring to FIG. 3, the thin film or thick film microcircuit 21 is deposited on the microcircuit substrate 20. An electrical insulating film 25 is deposited over the microcircuit film 21 and the pyrotechnic film or coating 13 is deposited over the insulating film 25. The pyrotechnic film 13 has leads 26 adapted for connection to the microcircuit or to an external power source, as desired, to energize and ignite the pyrotechnic material whenever desirable and feasible to do so to avoid compromise.

Referring to FIG. 4, the thin film or thick film microcircuit 21 is deposited on the microcircuit substrate 20 and the pyrotechnic material is deposited in layers. The first layer is a perfluoropolymer film 30 with a film of aluminum 31 deposited thereover. The aluminum thin film may be connected electrically through a switch to a voltage source or a top layer of nichrome 32 may be deposited over the aluminum and connected to the destruct circuit, as desired. The nichrome film will act as igniter for the pyrotechnic films of aluminum and perfluoropolymer.

The perfluoropolymer and metal mixtures providing the pyrotechnic reactions may be of any of the well known mixtures as listed hereinbelow although best results are acquired where the fluorine content is high. Two good examples of high fluorine content are polyfluoroethylene, commonly known as TEFLON, and perfluoroalkylenetriazine. Good powdered metal constituents are magnesium and aluminum. The following table discloses the pyrotechnic reaction of heat generated by several combinations of metals and fluorides:

TABLE I

Heats of Formation of Fluorides
and Enthalpy of Reaction of M +
Teflon — Metal Fluoride
Carbon. The Compounds Listed

are in Their Solid State Unless Noted Otherwise.		
Compound	ΔH_f° (298°K) (Kcal/mole)	Reaction of Element With Teflon ΔH° (reaction 298°K) (BTU/lb)

GROUP I, ALKALI METALS

LiF	-146	-5492
NaF	-136	-3277
KF	-135	-2431

GROUP II, ALKALINE-EARTH METALS

BeF ₂ (Liquid)	-227	-3961
MgF ₂	-266	-4105
CaF ₂	-290	-3853

GROUP III, BORON-ALUMINUM GROUP

BF ₃	-274	-2683
AlF ₃	-323	-3133
ScF ₃	-367	-3313
Y F ₃	-397	-2755

GROUP IV, CARBON-TITANIUM GROUP

SiF ₄	-371	-2467
TiF ₃	-315	-2359
ZrF ₄	-445	-2359

This table shows the standard enthalpy change for various Teflon-metal and Teflon-nonmetal systems. Examination of this table shows that magnesium-Teflon (-4105 BTU/lb.) and aluminum-Teflon (-3133 BTU/lb.) are extremely efficient systems based on their high enthalpy change of reaction (ΔH°). These systems are triggered by heat and once started are self-sustaining. The particles of the reactants should be intimately mixed, finely divided, and preferably of colloidal dimensions.

Although Teflon is the polymer which has been emphasized, other fluorine-containing polymers are also applicable. A polymer of perfluoropropylene epoxide, when mixed with aluminum powder, can be ignited and burns rapidly with intense heat. This polymer is available as a very viscous oil. It can be easily mixed with powdered metals and the mixture can be made into a stiff putty or dry paste. The polymer should be high in fluorine, should be stable in storage without any chance of spontaneous ignition, and must be malleable so that it can be easily mixed with metal powder.

The above-noted preferred embodiments of the eradication film or coating provide heat and flame of sufficient intensity to fuse, vaporize, or otherwise eradicate all circuit identification. This fusion is accomplished with a small quantity of reactant in a compatible integral part of the microcircuit. The reliability of the microcircuit or semiconductor devices attached to the microcircuit is not adversely affected by the reactants prior to eradication. These reactants are non-corrosive and are stable and when reaction is initiated, the pyrotechnic reaction takes place without explosion. The reaction of these destruct films evolves with only a minimum quantity of gas so that built up pressures will not shatter device packages or harm adjacent, non-critical circuits.

This eradication means is applicable for electronic circuits and electronic systems (especially those which are microminiaturized) which are of a critical nature, such that disclosure to enemy forces can be avoided.

5 Should the unfriendly party threaten, capture, or attempt to learn the identity of the circuit, the self-destruct mode could be switched and the perfluoropolymer-metal pyrotechnic reaction would destroy the critical portions of the anticompromise circuit.

10 While many modifications may be made in the combinations of perfluoropolymers and powdered metals and in the degree or extent of volume, it is to be understood that we desire to be limited in the spirit of our invention only by the scope of the appended claims.

15 We claim:

1. A pyrotechnic eradication means compatible with a microcircuit on a circuit film module comprising:

a microcircuit substrate;

20 a microcircuit film supported on said microcircuit substrate; and

pyrotechnic materials coating one surface of said microcircuit film with electrical conductors connecting said pyrotechnic materials and said microcircuit film adapted to conduct a current to energize said pyrotechnic material, said pyrotechnic materials being from a group of perfluoropolymers high in fluorine content and metals whereby said microcircuit film can be destroyed by exothermic reaction when said pyrotechnic materials are heated to the ignition point by electrical energization.

2. A pyrotechnic eradication means as set forth in claim 1 wherein

35 said pyrotechnic material coating said microcircuit film operates as a bonding agent between said microcircuit substrate and said microcircuit film, said perfluoropolymer material having electrical insulating qualities for said microcircuit film.

40 3. A pyrotechnic eradication means as set forth in claim 1 wherein

said pyrotechnic materials coating overlies said microcircuit film, said perfluoropolymer operating as an electrical insulating material.

45 4. A pyrotechnic eradication means as set forth in claim 1 wherein

said pyrotechnic material of perfluoropolymers and powdered metals are from the group mixtures consisting of lithium fluoride, sodium fluoride, potassium fluoride, beryllium fluoride, magnesium fluoride, calcium fluoride, boron fluoride, aluminum fluoride, scandium fluoride, yttrium fluoride, silicon fluoride, titanium trifluoride, and zirconium fluoride.

50 5. A pyrotechnic eradication means as set forth in claim 1 wherein

said perfluoropolymer material is of the group consisting of polyfluoroethylene and perfluoroalkylenetriazine and said metal is of the group consisting of aluminum and magnesium.

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