TCSET'2014

"MODERN PROBLEMS OF RADIO ENGINEERING, TELECOMMUNICATIONS, AND COMPUTER SCIENCE"

Proceedings
of the International Conference
TCSET'2014
Dedicated to the 170th anniversary of
Lviv Polytechnic National University

Lviv-Slavske, Ukraine
February 25 – March 1, 2014

Ministry of Education and Science of Ukraine
Lviv Polytechnic National University

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Technology of the Thick-film Microassembly with the use of Cu-contain Nanocompositions

Shamil Kurmashev, Ivan Vikulin, Aleksandr Sofronkov

Abstract – **The conductive pastes on the basis of Cu-contain nanocompositions for firing-on in a neutral atmosphere were studied at this work.**

Keywords – **microassemblage, monolithic very large-scale integrated circuits, thin-film hybrid integrated circuits, nanocompositions.**

I. Introduction

Wide distribution of thick- film technology in the production of the radio electronic apparatus of the different setting is conditioned, fore most, by her simplicity and reliability as compared to the processes of making of the monolithic very large-scale integrated circuits (VLSIC) and thin-film hybrid integrated circuits (HIC). With using thick-film technology passive part of the hybrid device formed. Active elements (semiconductor devices, monolithic integrated circuits) are assembled on the thick- film plate as added components. Such technology combining passive thick-film part with active added components carries the name hybrid.

II. Results and discussion

In the production of microelectronic devices (for the production of HIC, VLSIC and various types of the microassembly) ide distribution was got by thick-film technology of forming passive part microassembly because of high reliability of manufactured products, simplicity, cheapness and availability. Passive elements in thick film technology (conductors, resistors and dielectrics) are manufactured using appropriate pastes, which are compositions consisting of a functional filler, glass powder and an organic binder.

Shamil Kurmashev - Odessa A.S. Popov National Academy of Communication, Kovalska str., 1. Odessa, 65029. Ukraine,e-mail:kurmasch12@gmail.com.ua

The technology is based on the method of thick film screen printing. The plates for thick film microassemblage are typically made of alumina ceramic comprising 94 or 95% Al_2O_3. After heat treatment the conducting, resistive and dielectric layers are composites with different amounts of the glass matrix and the corresponding functional fillers. Until recently, the basis for the conductive and resistive compositions were scarce and expensive precious metals and their compounds (Au, Ag, Pd, Pt, etc.). Work aimed at replacing non-precious precious metals in the compositions for conductive pastes are economically viable and contribute to the wider adoption of thick-film technology in mass production of micro assembly for microelectronic devices.

It is presently possible to mark the row of developments of conductive compositions on the basis of copper, nickel, aluminium, cobalt, tungsten, zinc and other ignoble metals, and also their combinations, and resistance compositions on the basis of rare-earth metals, oxides of tin and molybdenum. Data about the worked out composition materials testify that Cu-containing conductive compositions possess the complex of very valuable properties: allow to form thick-film elements with high warm and by conductivity, well solder able, not subject to lixiviating in a molten solder, have a low cost and not contain scarce materials. However, at high temperature treatment (process of firing-on) necessary for forming of conducting layer, a copper quickly oxidizes and material loses the electro-conducting properties. In technology of conducting thick-film elements it is necessary to envisage protecting of materials from oxidization in the process of firing-on. Due to the introduction of the respective components in the composition to provide protection against oxidation processes conductor layers and their compatibility with the resistive and dielectric elements.

In some cases, to prevent oxidation of the base included in the composition of the films is carried out by heating the metal in a neutral or reducing atmosphere (nitrogen or argon). This complicates and, consequently, increases the cost of manufacturing process microassemblies. A more promising from the viewpoint of simplification of technology for production of conductive elements on the copper-based compositions, is a technology that uses high-temperature processing of compositions in air.

The comparative analysis of electro-physics and chemical properties of row of conductive elements allows to ground the choice of copper as functional material of explorer pastes of thick-film VLSIC.

The conductive pastes on the basis of copper for firing-on in a neutral atmosphere were studied at this work. This technology is able to provide high technical characteristics of the got conductive elements and fully to exclude precious metals from composition for the microassembliy of mass application. An achievement of high results is in the use of conductive pastes for firing-on in a neutral atmosphere, it is related to application as their functional material of copper, possessing necessary electro-physics properties. On the conductivity a copper yields only to silver. In addition, a copper has a subzero enough temperature of melting on connection with other ignoble metals (except for an aluminium). As is generally known [2] the size of the temperature of melting (T_m) renders influence on the processes of the recrystallization, i.e. on the height of grains in the process of the sintering of the powders. Most intensively recrystallization flows at temperatures on 15...25% below T_m. Thus, for copper powders under other favour able terms of the sintering will take place in the range of temperatures from 820 to 920 ^{0}C. For ultra dispersion powders with the sizes of particles of order (10...100) nm there was an effect of decline of temperature of melting.

Research of the structure of the layer by the method of electronic microscopy showed that the height of grains at forming of the conductor took place as a result of mechanism " of neck-formation " [3].

The copper conductors got firing-on in a neutral atmosphere have high enough the adhesion to plate, arriving at 200 kg/см^2, that it contingently chemical co-operation of layer and the plate. In the process of firing-on of copper paste on Al_2O_3 plate there is formation of aluminate of copper the under temperature of order of 800^{0}C on the border of division layer - plate. If the firing-on is produced at more subzero temperatures, connection of the layer with the plate is provided due to introduction to paste of fusible glass containing the oxide of copper in the composition.

It is certain that forming of Cu-containing conductive elements on air requires the use in composition of repairer. Application is reasonable as a repairer of the coniferous of boron.

III. Conclusion

It is shown that the most perspective resistance compositions on the basis of ignoble metals are compositions containing nano-size granules of the glass with cut-in in him of molybdenum and restoration agent (boron).

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