Paper No. T1-1.2, pp. 1-2

15th INTERNATIONAL SYMPOSIUM on POWER ELECTRONICS - Ee 2009
XV Međunarodni simpozijum Energetska elektronika – Ee 2009
NOVI SAD, REPUBLIC OF SERBIA, October 28th - 30th, 2009

POWER RESISTORS FOR HIGH FREQUENCY APPLICATION

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Abstract: *One of the main problems in power electronics is using resistors with low parasitic capacitance and inductance. These parasitic components are as a result of the high length and large surface of the resistor element. The length and the surface are determined for high voltage application or high power dissipation. In this work two common technologies are described:*

- *film resistors (thin film and thick film technologies);*
- *bulk (solid state resistors).*

The main parameters of each group are discussed as follow:

- *Nominal value of resistance from 5 ohms up to 5 Mohms;*
- *TCR less than ± 100 ppm K^{-1};*
- *Stability better than ± 1%;*
- *Power dissipation over 500 W.*

The comparison between parameters of the resistors and the price (cost) is done. The last discussions are on the applicability of the specific technology and specific design.

Key Words: ***power resistors, high frequency resistors, film resistors, bulk resistors***

1. INTRODUCTION

The problems of use power resistors in power electronic equipment is high frequency. From one side high current (high dissipating power) needs large resistor surface, it means high parasitic capacitance.

For high voltage (usually high ohm resistor) the problem is the total length and parasitic inductance. There are many producers and information about these kind of devices but they can be divided into two main parts:

- bulk resistor [1÷3];
- film resistors (thin or thick) [4÷6].

The information given above includes only production data but in the same time there are scientific works in the field of those problems [7÷10].

Following this, the main problems are:

- type of resistor (bulk or film);
- construction (design and topology);
- resistive materials;
- substrates and power dissipation.

The goal of this work is to show possibility to produce in laboratory conditions small series or individual samples of resistor for experimental work.

2. SAMPLE PREPARATION

2.1. Thin and thick film substrates

The main parameters for these substrates is high isolation R_i (dielectrics) and high thermo conductivity λ.

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Table 1.

Substrate	Al_2O_4	AlN	BeO	Stainless steel
$\lambda(W/mK)$	20	280	350	~20
Price	low	high	very	low
compared			high	

It is clear that metals and metal alloys are not suitable for this purpose. There is one exception – alkali free glazed stainless steel. The choice of substrate depends on the properties and price – Table 1.

2.2. Design and technology of the resistors

Bulk resistors.

The bulk ceramic resistors from boron carbide are prepared using conventional hot pressing process. The temperature and pressure are in the range of 2200 °C and 20 atm.

The duration of the sintering process is approximately about 15 min. After the preparation the samples are carefully cleaned from graphite and then the external contacts are made.

Film resistors.

For preparation of film resistors the commonly used techniques are used – thin and thick film technologies

(thin film deposition and screen printing respectively). As materials for thin films nichrom (Ni : Cr = 80 : 20) is preferred, because of its low temperature coefficient (less than 1ppm.K^{-1}). The final contacts on NiCr are 1:5 μm Ni and Au. For preparation of thick film resistors the classical BiROX pastes are used with sheet resistance of 10 ohm/sq and Ag/Pd low ohm contacts.

On figure 1 the typical constructions of the resistors are shown.

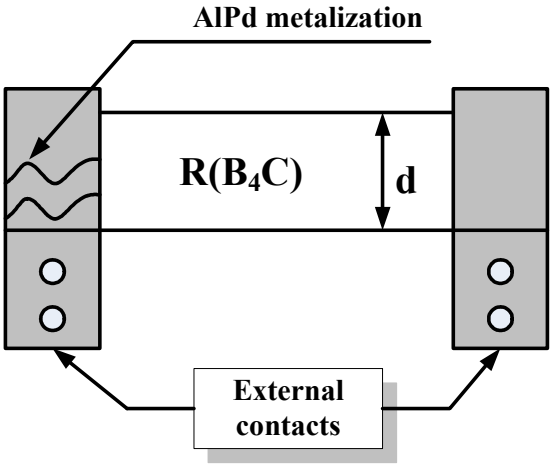

Figure 1a. *Bulk ceramic resistor*.

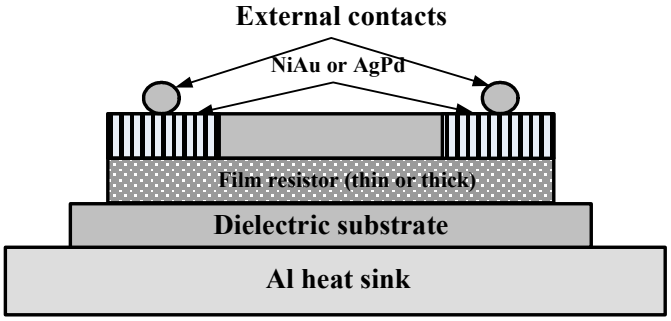

Figure 1b. *Film resistors.*

3. RESULTS AND CONCLUSION

After the preparation power resistors have electrical parameters as follows:

- Bulk ceramic

$R_{nom} = 2 \div 10$ *ohms*

$TCR = -1000 \div 1500\ ppmK^{-1}$;

- Thin film $NiCr(80:20)$

$R_{nom} = 10 \div 100$ *ohms*

$TCR \leq \pm 10\ ppmK^{-1}$;

- Thick film BiROX=10 ohm÷10 Mohms

$TCR \leq \pm 100\ ppmK^{-1}$.

It is clear that using appropriate technology and choice of materials the large area of power and high voltage resistors can be produced. Usually the power dissipation is over 10 W/cm^2 and voltage isolation over 1000 W/cm^2.

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