



TRIMMING THE FILM RESISTORS FOR HIGH VOLTAGE AND HIGH CURRENT (POWER) APPLICATION

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Abstract: The goal of this work are specific methods of adjusting film resistors for power application. The well known methods of trimming is using mechanical or electrical (E beam, laser, spark) removing parts of the resistor films. Some times after such kind of treatment there are potentially dangerous areas on the surface – conductive particles, scratches etc.

In this situation nondestructive methods are used. Especially they are: oxidizing the film surface (for Ta, TaN, NiCr), recrystallisation after thermal treating (in vacuum or N₂, Ar atmosphere) or a using short, high voltage pulses. As a result the film resistors (thin or thick) could be adjusted to $\pm 1\%$ (and low) without mechanical destructions and keeping low TCR about $\pm 100 \text{ ppm K}^{-1}$ (or less). The rang of trimmed resistors is between 10 ohms to 10 Mohms.

Key Words: power resistors, resistor trimming, pulse trimming

1. INTRODUCTION

Usually power resistor are not in the area of precise elements, but for some application they must have tolerance better than $\pm 1\%$. There are many producers and from data sheets it could be seen that the tolerance is from 1% to 10% for the range of resistor values from 10 ohms to 1 Moms [1÷3]. In the same time power dissipation is over 100 W and voltage over 1000 V.

The reach such kind of accuracy the resistors need individual trimming. The best results are obtained using short electrical pulses without thermal influence [4÷8].

The goal of this work is using pulse trimming method for adjusting thin and thick film power resistors. It means trimming without any kind of mechanical, thermal influence and destruction.

2. SAMPLE PREPARATION

2.1. 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 1 ppm.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÷1 Mohm/sq and Ag/Pd low ohm contacts.

3. EXPERIMENTS

The main particularity of these experiments is to apply high voltage pulses for very short time and to prevent the heating of the resistive materials. It means that only electric field will act onto the properties of the resistors. The block circuitry is shown on the figure 1.

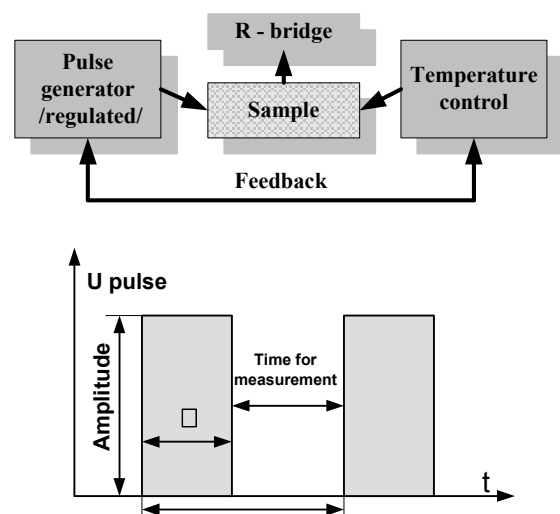


Fig. 1.

In the experimental work rectangular pulses are used with amplitude between 100 ÷ 150 V, frequency 100 ÷ 1000 kHz and duration $\tau = 1 \mu\text{s}$. One of the main parts of the equipment is the block for temperature control where

the total heating of the resistors could be measured and the process of pulse treatment could be stopped.

4. RESULTS

After treatment of the samples for time between 10 min and 60 min the changes of the resistance and TCR were observed. The typical curves are presented on figure 2.

From these curves three zones could be determined:

- first zone is of the significant change of the resistivity(decreasing of the nominal value);
- second zone – flat and with small changes;
- third zone of continuous increasing of the resistance. It could be mentioned that the behavior of the samples is not identical, but the changes are common for three groups.

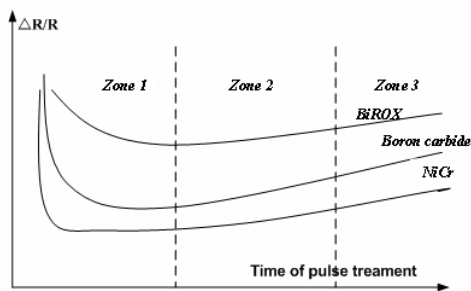


Fig. 2.

5. DISCUSSION

The presence of the first zone of decreasing of the resistance could be explained with the homogenization of

the structure as a result of the high electric field and local (in very small areas) heating. Next zone (II) of relatively stable work shows that the process is almost finished and another structural changes could not be expected.

Zone III is interesting with its increasing of the resistance. It is mentioned before that the samples are low ohm and processed between resistive materials and contacts are not included.

These interfaces act significant onto the total nominal of the resistors and changes are not reversible in more cases. Those experiments show that low ohm resistors could be produced in close tolerance only by sorting and pulse treatment without any kind of mechanical destruction of the resistive materials.

6. REFERENCES

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