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ELECTRIC PHENOMENON ANALYSIS OF ELECTRIC CONTACTSMAIN HEADER

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Abstract: *The article describes problems of stationary contacts and description of the discharge inception processes, which are related to the function of stationary contact. These are e.g. problems so - called contacts sparking, it is study in light of interfering fields generation. The theory is in connection with questions of electromagnetic compatibility. The measurements on the heterogeneous structure of the surface layers in the electrical contact bring many interesting results.*

Key words: *electric contact, stationary contact, contacts sparking, electric intensity, surface layer, discharge inception process*

INTRODUCTION

The quality of the contacts in the circuit is given the correct function of the electrical installation. The difficulties of the electrical contact safety are caused by the heterogeneous structure of the surface layers in the electrical contact, which are rising from the interaction with the environment so it is not easy to say the true value of the contact resistance.

The major interest is concentrated on problems of stationary contacts and description of the discharge inception processes, which are related to the function of stationary contact. The theory is in connection with questions of electromagnetic compatibility.

The measurements on the heterogeneous structure of the surface layers in the electrical contact bring many interesting results.

1 ELECTRICAL CONTACT RESISTANCE

All solid surfaces are rough on the micro scale. Surface microroughness consists of peaks and valleys whose shape, height variations, average separation and other geometrical characteristic depend on fine details of the surface generation process. Contact between two engineering bodies thus occurs at discrete spots produced by the mechanical contact of asperities on the two surfaces, as illustrated in figure 1. For all solid materials the area of true contact is thus a small fraction of the nominal contact area, for a wide range of contact loads. The mode of deformation of contacting asperities is either elastic, plastic or mixed elastic-plastic depending on local mechanical contact stresses and on materials properties such as elastic modulus and hardness. In a bulk electrical interface where the mating components are metals, the contacting surfaces are often covered with oxide or other electrically isolative layers. The interface becomes electrically conductive only when metal to metal contact spots are produced, i. e. where electrically isolative films are ruptured or displaced at contacting surface asperities. In a typical bulk electrical junction, the area of electrical contact is thus appreciably smaller then the area of true mechanical contact.

In a bulk electrical junction, the electrical current lines become increasingly distorted as the contact interface is approached and the flow lines bundle together to pass trough the separate contact spots as illustrated at figure 1. Constriction of the electrical current by contact spots reduces the volume of material used for electrical conduction and thus increases electrical resistance. This increase in resistance is defined as the constriction resistance of the interface. Often, the presence of contaminant films of relatively large electrical resistivity on the contacting surfaces increases the resistance of contact spots beyond the value given by constriction resistance. The total interfacial resistance provided by the constriction and film resistances determines the contact resistance of the interface.

The present chapter reviews some properties of electrical contacts and updates the reader on the results of recent research.

2 THE EFFECT OF SURFACE FILMS ON CONSTRICITION AND CONTACT RESISTANCE

The presence of a film at the interface of an electrical junction affects contact resistance in a variety of ways. If the films is present initially on one of the contact surfaces and is electrically conductive, the constriction resistance of a contact spots is either decreased or increased relative to the resistance produced by the identical contact spots on the uncoated surface, depending on the electrical resistivity of the film material relative to that of the substrate. A change in mechanical hardness due to the presence of the film may also affect contact resistance. If the interfacial layer is formed by the interdiffusion of dissimilar materials across the contact, contact resistance will often increase through the formation of electrically resistive intermetallic compounds. If the film is electrically insulating or only weakly conducting, a good electrical contact is established only if the film is mechanically disrupted to allow the formation of metal to metal junctions. This section reviews the effect on constriction and contact resistance of electrically conductive layers such as electroplated layers, electrically resistive layers such as contaminant surface films and electrically insulating interfacial layers.[1]

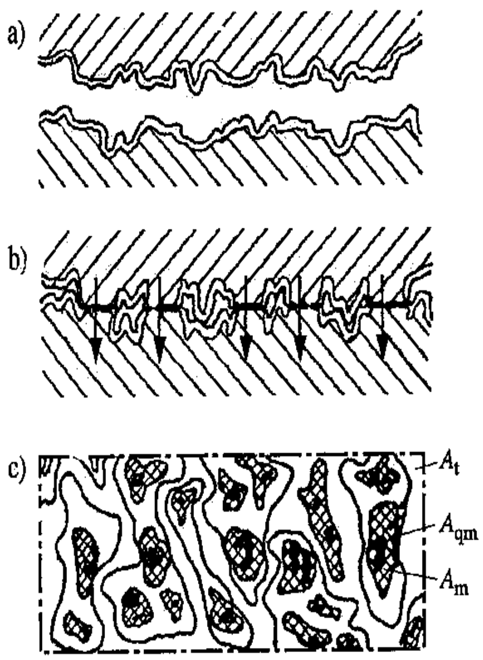

Fig. 1. Stationary contact with thin alien film, [1]

3 DISCHARGE INCEPTION ON ELECTRIC STATIONARY CONTACT

The stationary contact is shown in the figure 2. This configuration of the stationary contact is modulated with thin film, practically with non - conducting thin film on contact surfaces.

The contact is not able to conduct the electric current because of enormous growth of surface layers resistance. The electric voltage of a power source is on the stationary contact. It presents the electric contact formation with compound dielectric air – alien film, with fissure air gap (Fig. 2).

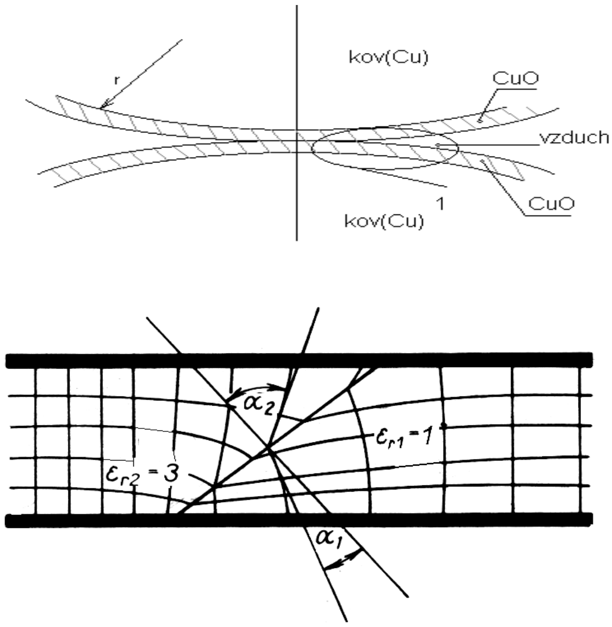

Fig. 2 .: Stationary contact with thin alien film, Settlement of two dielectric with different absolute permittivity [4]

It is known, that the intensity of electric field increases in such settlement of two dielectrics with different absolute permittivity and with a sidelong interface to the electric field lines direction. The intensity of the electric field has the highest values in the gap of dielectric with smaller absolute permittivity (Fig. 2 [4]).

This strong electric field intensity increase can be reason of the glow discharge generation in the electric contact in view. (Fig. 2) This glow discharge can be ignited in the air gap also at a relatively low voltage. The AC voltage has a discharge character of partial discharge; it is capacitive blocked to the electrodes. The degrees of thermal decomposition of surface layers can cause their thinning, increase of discharge current and change of the electric arch character.

4 THE VOLTAGE CHARACTERISTIC MEASUREMENT OF ELECTRIC CONTACTS SURFACE LAYER DETAILED REMARKS

The research is concentrated on the explanation of discharge inception processes in the electric contact with surface layer caused by oxidation.

It was measured repeated the electric contact with surface layer rising natural corrosion and also on the electric contact with surface layer made up of acid treatment. The surface layer is like collection of different type of different corpuscles, different crystal set with micro porosity.

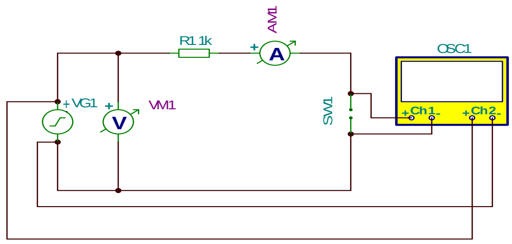

Fig.3. Wiring diagram of electric contact measurement

The measured contact was wired in the circuit with source of regulated voltage. It was measured current passing through the electric contact and the oscillograph monitored voltage on the electric contact and source voltage. The source voltage was increased in sequence at low voltage (5V-230V)

During repeated measurement the contact part was transfer in the space mechanical clearance. The contact was move along the surface of electric contact.

The heterogeneous structure of the surface layers in the electrical contact have semiconductor characteristic with different type of electric conductivity. The behavior of the surface layers in the electrical contact depends on type of crystal set conductivity under electric potential.

5 Measurement results

The semi-conducting surface layer in the point of connection changes character of voltage. In this kind of connection is not attended to the discharge inception in micro porosity.

The figure (Fig. 4.) shows the voltage characteristic with the discharge. The result of measurement confirmed, that the heterogeneous structure of the surface layers in the electrical contact in the point of connection conduct the current. Probably in the micro gap is discharge inception, it is possible to see on figure 4. This kind of voltage characteristic was appeared the most frequently.

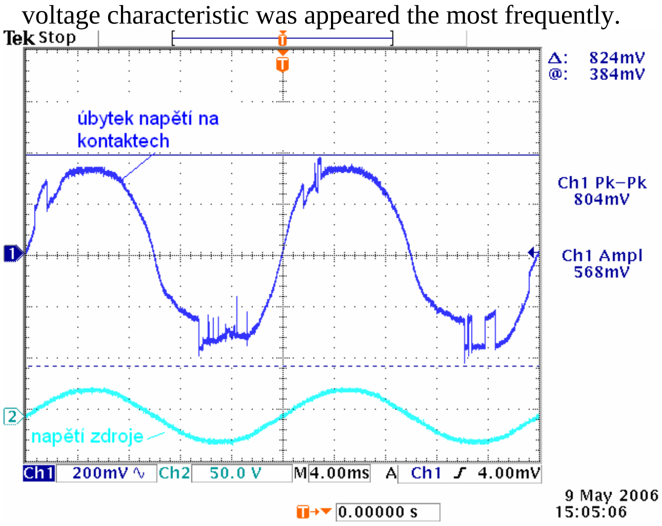

Fig.4 Voltage characteristic on the surface layers in the electrical contact

The semi-conducting surface layer in the point of connection changes character of voltage. The voltage characteristic is analogous with the voltage characteristic of Zeners diode (Fig. 5.). In this kind of connection is not attended to the discharge inception in micro porosity.

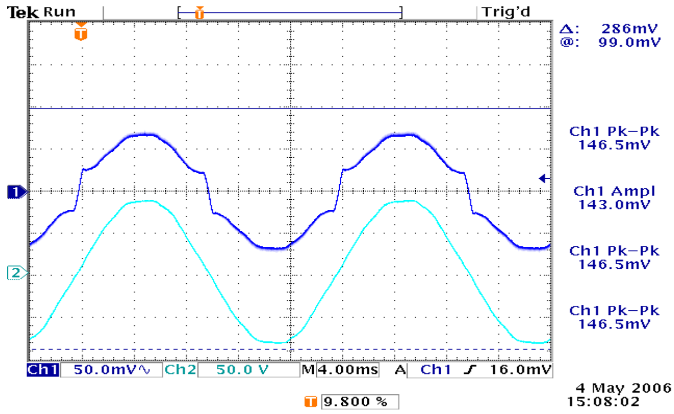

Fig.5. Voltage characteristic on the surface layers in the electrical contact

6 Conclusion

The heterogeneous structure of the surface layers in the electrical contact has different mechanism of electron transfer in comparison with the bulk material.

The electric field is collected in the small gap among the isles. The electric field is gained strength, it cause processes like tunnel effect, Schottky emission, hot electron emission.

The heterogeneous structure of the surface layers in the electrical contact can conduct good -sized current as well.

The variation of the isles characters and the single cells are caused by three phenomenon groups at once. It is dimension attributes, also surface phenomena especially in small element and abnormalities in element structure compared the bulk material.

The cross interaction of isles group conduce to variation in the heterogeneous structure of the surface layers in the electrical contact.

The research continues in analysis of the discharge mechanism

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