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Study of Cu-Al contact pair

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One of the main problems of energy that occurs when you connect the electrical connections is an electrochemical process that occurs during prolonged interaction of Cu and Al. The problem lies in the fact that aluminum is more active metal than copper[1]. Under normal conditions, the surface of aluminum products an layer of oxide, which deteriorates the conductive property. In this regard, an electrical contact becomes worse. The layer of oxide formed on the surface of copper products, does not affect the quality of the contact. The phenomenon of electrochemical incompatibility metal contact and therefore begins to warm up. If moisture gets begins the process of electrolysis, which destroys the contact and makes the connection to the potential fire hazard. Also, this terminal pair has a high value of the contact resistance of the transition, resulting in an increase in electricity losses.

Currently, there are several ways of combining the contact pair copper – aluminum. First, use of the bimetallic plate. Secondly, use of lubricants on the conductive contact of the copper powder. Thirdly, use of transition metal protective, abrasion-resistant coatings.

This paper proposes a new solution combining contact pair Cu-Al and reducing its transitional contact resistance by acting on the contact surface of the aluminum high-speed pulsed electrical discharge plasma jet generated copper coaxial magnetoplasma accelerator.

Conductive grease

Aluminum surfaces exposed to additional training before joining. Primarily made machining aluminum contact surface of sandpaper with an average grain size of the abrasive particles. Then sweep the surface of the layer of oxide . Due to the fact that the aluminum product in contact with air immediately covered with an layer of oxide, the cleaning of the surface layer produced by petroleum jelly, followed by coating the treated surface of the protective grease or paste, preventing oxidation of the metal.

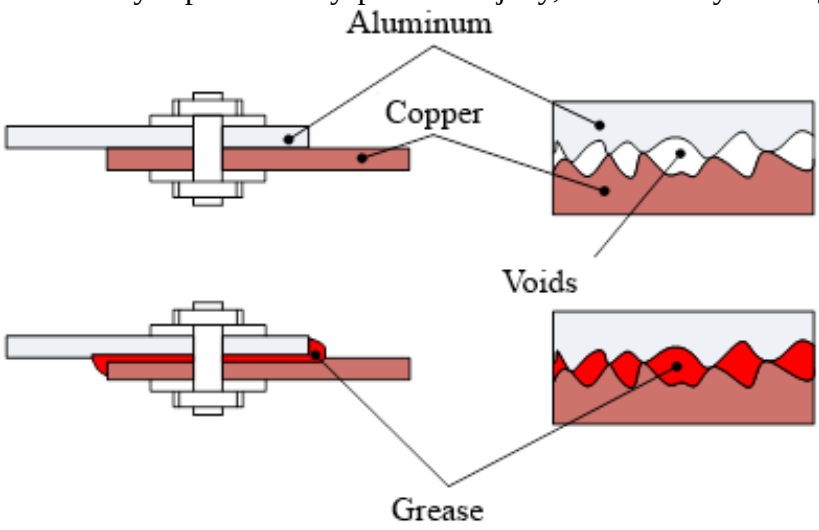


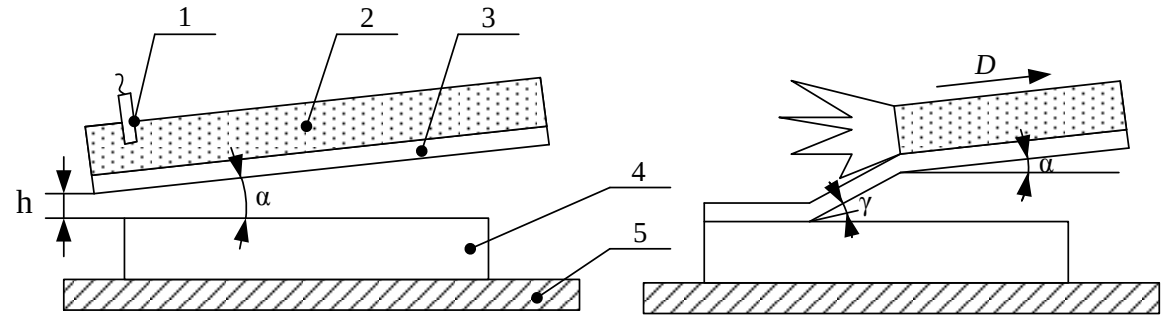
Figure 1 (left) – Principle of operation of conductive greases.

The use of conductive greases to reduce the transitional resistance in contact electrical contacts maintains their functional properties during thermal overloading (at a temperature up to 350-4000 °C). In addition, the conductive grease can provide corrosion protection of electrical contacts in an aggressive and humid environment. But as a result of prolonged cyclic loading conductive grease loses its properties and can not be reused as a result of the audit contacts[1].

Bimetallic Strip

Transient copper – aluminum gaskets are used for joining aluminum to copper conclusions tires electrical devices, as well as to the copper bars. Currently, more widely used in the production of composite materials technology has explosive welding.

Explosion Welding – is a welding method which uses the energy of the explosion. The part to be welded is located at an angle to the stationary target. As a result of the collision of parts of the explosion occurs metal jet stream, which spreads over the surface of parts, so that the plastic deformation occurs together the two parts and they are welded.



a) b).

Figure 2 – The angular diagram of explosion welding to the beginning (a) and the step of explosion (b): 1 – detonator 2 – explosive 3 – Metal plate 4 – the fixed plate 5 – Bearing.

Use of bimetallic plates allows combining a pair of contact Cu-Al, but the result is an increased number of contact junctions, which leads to a transient increase in the contact resistance and causes additional heating of the contacts, and additional power losses[3].

Protective coatings

Method of cold gas dynamic spraying

Method of cold gas dynamic spraying is used to restore the surface of products, strengthening and protection of metals against corrosion, improve thermal and electrical conductivity, etc.

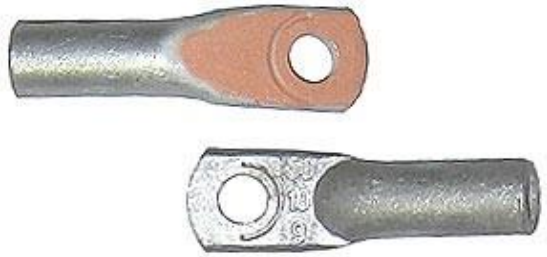


Figure 3 (left)– Aluminum ferrules with copper plating.

In the gas dynamic technology applied to the substrate particles with a lower temperature, but having a very high speed (500 ... 1000 m / s).

Sputtering materials – polymers, carbides and metals – forming thermal barrier, wear and corrosion resistant coatings that can withstand the impact of chemically aggressive environments, high heat loads. As deposited (consumables) materials used fine and ultrafine powders with a particle size of 0.01-0.5 mm.

Advantages and disadvantages of gas-dynamic method.

- The coating is applied in an air atmosphere at normal pressure.
- In the area of coating product temperature does not exceed 100-150 °C. From this it follows that completely eliminated the occurrence of internal stresses in the products and their deformation, as well as oxidation of coating materials and components;
- The technology for environmentally safe coating.
- There is a cleaning of the surface from contamination due to the impact of technical high-speed flow of the spray particles.
- Feed the spray particles is highly directional and has a small cross-section.

The only disadvantage is the possibility of gas-dynamic spraying the coating only from relatively ductile metals such as copper, aluminum, zinc, nickel, etc.

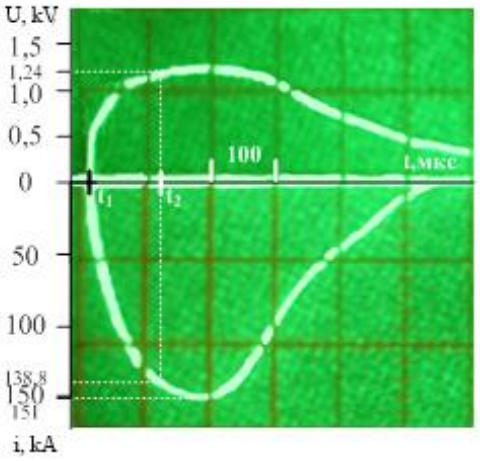
The operating principle of magneto coaxial accelerator

In the initial state coaxial magnetoplasma accelerator is included in the discharge circuit capacitive energy storage accumulator C charged to the required voltage U_z. With the clo-

sure of the key K at the time t_0, on the interelectrode gap voltage is equal to the charging voltage of the capacitive storage U_z.

In accordance with the laws of classical voltage maintains a constant level for some time. At time t1 occurs gap breakdown. In the circuit begins to flow operating current i(t). Breakdown delay time does not exceed 100 ÷ 150 ms. After the release of plasma from accelerating channel voltage starts gradually decline to nearly exponential law. At time t_2 the power consumption is stopped.

Plasma harness Z – pinch plasma and circular short-circuiting on the cylindrical surface of the accelerating channel, make the plasma structure, as the formation of which the discharge voltage is reduced to the level of the arc stage and going the speed limit upslope.



Steady state plasma structure is provided by the magnetic field pressure of its own current and magnetic field of the solenoid pressure axial external induction system.

Axial field of the solenoid and provides axial plasma acceleration due to compression of the plasma structure and axial displacement of the conducting medium.

Figure 4 (left) – Typical waveform current i (t) and voltage U (t).

During the operation of the accelerator in the discharge is continuously growing and is involved in over the mass of material accumulated by electro discharge from the surface of the accelerating channel. This material shall be made of jet acceleration channel and is the basis for the coating of the target – substrate positioned at some distance from the muzzle coaxial magnetoplasma accelerator.

Investigation of physical and mechanical properties of the coatings

Based on the terms of the research optimal energy parameters for copper plating are: capacitance of the capacitor bank C = 12 · 10-3 F, battery voltage U_z = 3 kV. Technological cycle is carried out under atmospheric conditionsP_0 = 1,0 atm. An energy storage capacitor W_c = 73.5 kJ, distance from the muzzle to the target of 180 – 420 mm. Under these conditions, one cycle is applied to the copper coating on an aluminum surface area of about 100 cm^2. The coating thickness is not less than 100 microns [2] The ring-shaped contact

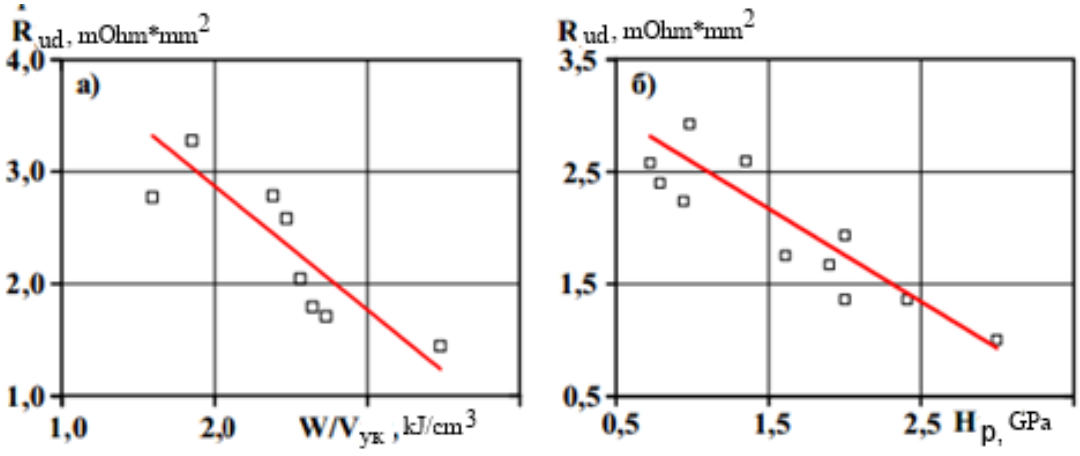


Figure 5 – Dependence R_{ud} from Figure 6. Dependence of R_{ud}.

elements made of aluminum coated with a copper coating combined with the same contact elements and tied up isolated pin. According to these experiments was the dependence of the specific contact resistance of the transition (R_{ud}) on the specific input energy (W / V_{uk}) and on micro hardness of the boundary layer (H_p) for maximum torque bolting M = 100Nm.

W / V_{uk} at M = 100 Nm. H_p at M = 100 Nm.

Study of the phase composition was conducted by X-ray diffraction (XRD). Figure 7 shows the XRD – experimental spectra obtained with the same initial conditions, with different input energy and according to different hardness values in the boundary layer coating-substrate. As can be seen, the main crystalline phase coatings are Cu (space group F 4 / m – March 2 / m) from 67,3 to 75,2%, Al (GHG F 4 / m – March 2 / m) from 2.9 to 26,9%, AlN (PG 4 F / m – 2 March / m) of from 0.5 to 21.7 %, with a slight presence of CuO (PG 4 F / m – 2 March / m) from 5.8 to 21 9 %.

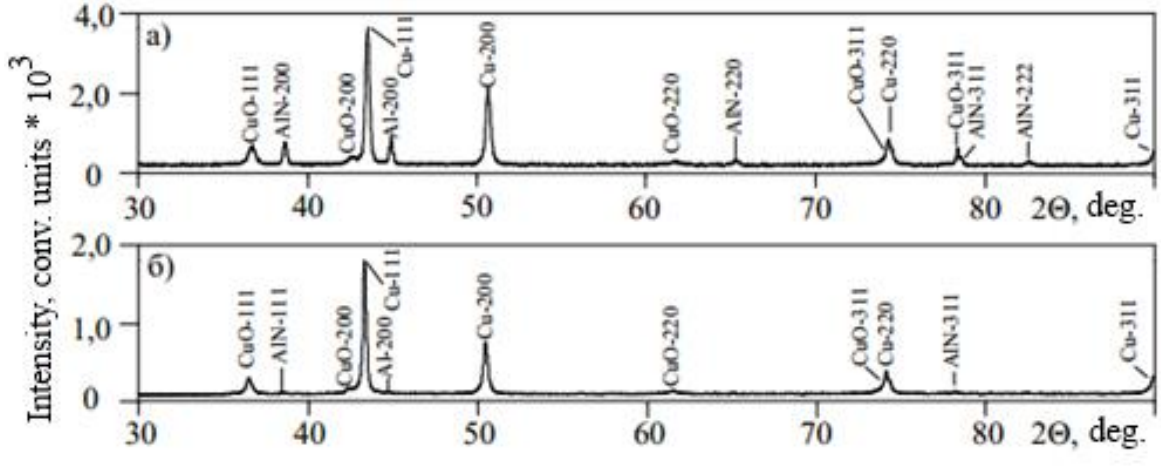


Figure 7 – XRD – spectra of the surface of thin copper coatings deposited in air on a substrate made of aluminum alloy) H_p = 2.0 GPa b) H_p = 1.3 GPa.

Obviously, the material falls into the Al coating to the substrate surface by melting and mixing at high speed hydrodynamic interaction of the jet with the substrate surface. Analysis of the main reflections and broadening the definition of coherent scattering material present in the crystalline phase shows that they are nanostructured. The microstructure of the boundary layer covering the substrate was carried out using optical microscopy on a microscope Olympus GX – 71. For this aluminum substrates coated with copper-coated specimens were prepared vertical cut with ground joints.

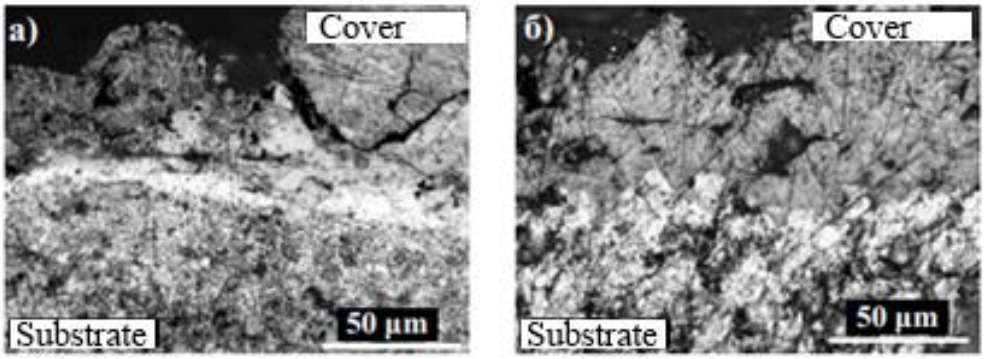


Figure 8 – Optical micrographs of the loop cross-sectional sample of aluminum with copper coating: a) H_p = 2.4 GPa b) H_p = 0.72 GPa.

The analysis revealed that the average coating thickness of ~ 100 microns, homogeneous structure and has practically no pores. In the boundary layer in Figure 8a clearly distinguished white color layer, an average thickness of about 20 microns, presumably AlN. This layer has a higher hardness value ~ 2.40 GPa. Figure 8b of this layer is not visible, and the hardness of the boundary layer is ~ 0.72 GPa. It was thus established that the hardness of the boundary layer depends on the concentration of nitride phases.

This method has the following advantages compared with the others: simplicity, low exposure time (10^{-3}s) and environmental friendliness. Not required dispensed material that works enough electro erosive by accelerating channel with surface copper trunk coaxial magneto accelerator. This method allows us to solve several problems. First, solves the problem of combining a contact pair copper -aluminum. Second, the contact resistance is significantly reduced and hence reduces the energy loss.

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Die Solarenergie in Deutschland

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Abstract: Im diesem Beitrag sind Belange und aktuelle Daten über die Entwicklung die Solarenergie in Deutschland betrachtet und die Analyse des Ausbaus und Nutzens des Solarmarktes in der Bundesrepublik gegeben.

Schlüsselwörter: Solarenergie, Solarbatterien, Leistung.

Das Allgemeine über die Solarenergie in der BDR

Die alternative Energetik wird in der Welt immer mehr gefördert. Die solare Energie bleibt dabei keineswegs abseits. Ihre Rangstufe entwickelt sich mit jedem Jahr unentwegt. Als Zeugnis sind die Materialien der Statistik EPIA. 2012 hat die allgemeine Leistung der Solaranlagen weltweit die Planke von 100 GW überschritten. Die gegenwärtigen Anlagen produzieren so viel Elektrizität wie 16 Kohle- oder Atomkraftwerke.

Europa liegt im Bereich der Solartechnik weltweit vorn. Deutschland kommt dabei eine entscheidende Rolle zu. Zurzeit legen die Deutschen alle Atomkraftwerke in ihrem Land aktiv still. Veranlasst wurde dies durch die Unfälle in Tschernobyl und Fukushima. Folglich entstand die Frage nach der Gewinnung der Energie aus den alternativen Quellen. Das sind Sonne, Wind, Wasser und andere.

Dank solcher Politik wurde Deutschland zum weltweiten Vorreiter auf dem Gebiet der Einführung und Investition in die Solarenergie (Prognose von 2010).