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The influence of low voltage discharges on structure and phase transformations of metallic foils

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A low voltage electrospark processing of materials allows one to modify the chemical composition and structure of metal layers due to thermo-mechanical influence of discharges and transfer of materials from one electrode to another. The coating, formed by electro-spark deposition, consists of an alloy of both electrodes' materials and products of their interaction with an interelectrode gas environment. The most of electrospark studies are devoted to the investigation of connections between electrode materials, discharge electrical characteristics and properties of coatings. In this work a special attention is devoted to studying of physics chemical processes caused by discharges.

Our experiments have shown, that influence of electric discharges leads to occurrence of cathode deepenings (erosion caps) surrounded by rings with various abilities of reflectivity and scattering. One can see a melting zone where a fusing material crystallizes after a single discharge influence. Grains of the melting area are drawing as moving to the discharge center. At a heat-affected zone adjoining to the melting area, the average size of grains increases.

The transition electron microscopy (TEM) investigation of copper foils also shows that the grain microstructure changes strongly after a single discharge influence. Diffraction patterns are single dots in the original area, but they begin to spread azimuthally at the discharge zone. The angle disorientation of grains increases as they approach to the discharge center; reflexes of adjacent grains appear. Then diffraction rings arise, demonstrating an appearance of a polycrystalline structure. An average grain size determined from broadening of diffraction maxima decreases from 100 μm to 10 nm approaching to the center.

In the tungsten anode case, the TEM investigation of a copper foil has shown that not only the anode and cathode materials but also products of interaction of both electrodes with oxygen are present at a discharge zone.

The copper and copper oxide phases were mainly found at the heat-affected zone, where the angle disorientation of grains was seen before a discharge too. Crystalline tungsten and tungsten oxide $WO_3(\beta)$ were found in the discharge center. Copper tungstenit $CuWO_4$ was found at 300－800μm from the discharge center.

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