CHEMICAL SILVERING OF WAVEGUIDE BODIES

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In the work there are experimentally chosen optimal compositions and regime of chemical deposition of silver on waveguide bodies, possessing much higher stability of the solution. The work gives the methods of the surface preparation, including annealing, fat removing in alkaline and organic electrolytes, etching, sensibilization followed by chemical deposition on them of a copper sublayer of copper sulphate.

It is known that bodies of waveguide devices are prepared of dielectrics (plastic or ceramics), which are subjected to metallization, mainly copper-plating and silvering. At present there are different technologies of metal cover deposition on waveguide bodies – burning-in, melting, electron-beam laser sputtering, etc. However, these methods require complex equipment and high energy expenditure.

For metallization of bodies of waveguide dielectrics the metal sputtering is used when the melted metal is sputtered by the gas spurt (air or argon) into smaller particles, which strike with high velocity (100-150 m/sec) against the metallized surface and adhering to it form the covering layer.

By sputtering one can deposit zinc, alloys of silver-cadmium and silver-tin, brass, copper, nickel, etc. For production of waveguide bodies multi-layered coverings are used. The first layer to deposit is the alloy of silver and cadmium possessing small resistivity. Its thickness is 0,25 \( \mu \)m. Then in order to give higher mechanical strength to the body it is covered with brass or copper up to the required thickness (3-5 \( \mu \)m). The coverings obtained by sputtering have low mechanical strength and porosity. Besides, metallization by sputtering is performed by special installations.

The most perspective technological method of silver deposition is the electrochemical method, precisely silver deposition from cyanide baths. Cyanide electrolytes have good scattering ability and high quality of deposits, but they have significant shortenings, they are poisonous and require application of electrical current.

Traditional non-cyanide methods of chemical reduction of silver are relatively high-productive, however their solutions are low-stable and significantly limit the sphere of their application.

Before metallization the most important operation is, as it is known, preparation of the surface of the waveguide body. Carefulness of the preparation influences greatly the covering service for any purpose. Before the chemical copper-plating the waveguide bodies were subjected to fat removing in the following solution (g/l):

- \( \text{NaOH} \) - caustic soda - 15
- \( \text{Na}_2\text{CO}_3 \) - calcined soda 10
- \( \text{Na}_3\text{PO}_4\text{•}12\text{H}_2\text{O} \) - trisodiumphosphate - 15
- \( \text{Na}_2\text{SiO}_3\text{•}n\text{H}_2\text{O} \) - liquid sodium glass - 25

at the temperature 40-50°C during 10-30 min.

Chemical etching of the body was carried out in the solution containing 60 g/l \( \text{H}_2\text{SO}_4 \) and 40 g/l HF at room temperature during 5-10 min. After the chemical etching the bodies are thoroughly washed with distilled water, then they are subjected to thermal treatment at the
temperature 60±10°C during 2 hours, followed by cooling together with the furnace. Ceramics annealing is used not only for moisture removing, but also for ensuring maximally strong adhesion of the covering with the base.

After the annealing the waveguide bodies were subjected to activation in the following solution (g/l):

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\text{SnCl}_2\cdot 2\text{H}_2\text{O} - 50 \\
\text{HCl} - 50
\]
at T=18-20°C during 20-30 min.

On the prepared surfaces of the waveguide bodies a copper sublayer from sulphate electrolyte was deposited by the chemical method. Formed conducting copper layer has a strong adhesion to ceramics and its thickness is directly proportional to the time of copper-plating: for 5 min it is equal to 5-6 μm, for 10 min – to 10-12 μm.

After deposition of the conducting layer and corresponding washing the waveguide bodies are activated in H₂SO₄ (50-100 g/l) during 30-50 sec at the temperature 15-25°C, then they are washed with distilled water and then silvered in the electrolyte based on AgNO₃ and KNaC₄H₄O₆•4H₂O. Silver deposition occurs during the first 20-30 minutes, and about 2 μm is deposited. For increasing of the covering thickness the body is thoroughly washed with running water, then with distilled water and is kept for 1-2 min in 10% aqueous solution of ammonia, then again it is silvered in the same solution.

Optical-microscopic analysis of silvered coverings testifies to non-porosity and uniformity of deposition on both internal and external surfaces of the waveguide bodies. The obtained coverings have high mechanical adherence with the base.