**Fabrication of Nanosized Elements with Specified Properties on Bulk Materials and Powder-Like Particles**

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There have been developed the methods of deposition of ultra-thin continuous electroless films and clusters with specified porosity on nanosized particles (carbon, carbides, oxides, borides, nitrides, diamond, zeolites, etc.). These methods allow us to obtain nanosized elements for microelectronics; nanostructured composite materials and coatings with specified properties; electrodes for fuel cells and batteries; conductive nano-sized additives to plastics and rubber; sensors; catalysts, etc.

The problems of the existing metallization methods are: complexity of obtaining ultra-thin pore-free or thick films with low internal stresses and high adhesion to non-metallic polished surface, high consumption and losses of precious metals, a long time required for fabrication of devices, complexity and expensiveness of the equipment for vacuum deposition or steam-gas metallization, high energy consumption, etc. The aim of the work was to overcome the abovementioned problems. For development of the optimum technology, we improved the entire cycle of the metallization process.

It is shown that the existence of the adsorbed tin ions provides both a greater number of palladium ions on the glass and greater strength of bonding of palladium to the surface. The optimal conditions for preliminary treatment of non-metallic surfaces depend on their state and nature. The conditions of activation such as pH, concentration and temperature of the palladium chloride solution, and surface roughness of the substrate determine whether the sensitization is necessary or not. The sensitization reduces the induction period of the nickel deposition reaction, promotes complete coverage of the surface and improves the coating quality.

There was established the mechanism of sensitization and activation. The part of the palladium ions not reduced by sensitization-activation:

$$Sn(II)+Pd(II) = Sn(IV)+Pd \quad (1)$$

can be partially reduced at subsequent interaction with hypophosphite in the solution of electroless deposition according to the reaction:

$$PdCl_4^{2-} + H_2PO_2^- + H_2O \rightarrow Pd + H_2PO_3^- + 2H^+ + 4Cl^- \quad (2)$$

A new method of production of precise piezoelectric quartz resonators and filters, and monolithic piezoquartz filters with electrodes made of electroless nickel-phosphorous and nickel-boron alloys for spacecraft, hydroacoustics and communication devices was developed. As a result of usage of the developed technology, Au, Ag and Pd were adequately substituted by non-precious metal alloys; the time for production of devices was reduced by a factor of 15, and the labor intensity of the technology was reduced significantly; frequency stability of piezoquartz devices was increased 1.8 times; the absolute value of dynamic resistance of piezoquartz resonators became 30 % lower and scattering of the resistance became about 40-50 % lower as compared to the resonators with silver-plated piezoelements. Several tens million items were produced. A technology of production of piezoceramic devices by electroless deposition of electrode layers made of Ni-P and Ni-B alloys for hydroacoustic equipment of submarines and ships, delay lines of color TV sets, etc. was developed (several hundred million items were produced). As a result, the time for production of piezoceramic devices was reduced by a factor of **100** as compared to high-temperature fusing of silver-containing paste, and Ag was adequately substituted with non-noble metals. Adhesion of the electroless coating to the non-metallic surface of any roughness is high. The adhesion exceeds even cohesion of quartz. There were developed the methods that allow us to substitute palladium chloride with inexpensive non-precious substances for activation of non-metallic powder-like particles and bulk dielectrics prior to electroless metallization.

The proposed methods of obtaining nano-sized metallic particles with large surface areas can be used for reduction of the thermal boundary resistance between liquid helium and solids (Kapitza resistance) and fabrication of unique thermal sensors, etc.

We designed a new device for determination of ductility by bending. The bending angle can be mathematically converted to percent elongation. The suggested design makes it possible to observe in-situ crack propagation and its character from the start to the finish at different rates of deformation and temperature. The suggested tester can help to overcome a number of cracking problems in micromechanics and flip-chip technology. The proposed ductility tester is used in industry.