Photoselective nickel deposition on SnO_2-coated glass

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Conductive metal patterns on the surface of dielectrics and semiconductors are compulsory elements of printed circuit boards, chips, waveguides, heating devices, etc. Traditionally, to obtain them, a continuous metal layer is first deposited, and then it is selectively removed using photolithography processes. More economical processes are known that consist in metal ions catalytic reduction only on the specified areas of the surface containing palladium nanoparticles as a catalyst. Processes using photosensitive titanium dioxide films have found practical application. Selective metal deposition on titanium dioxide films is due to its semiconducting properties. UV irradiation of TiO_2 film generates photoelectrons which are captured by palladium ions and reduce them either during irradiation or when treated with $PdCl_2$ solution after the UV exposure. TiO_2 films 0.1−0.2 μm thick are obtained by the sol-gel technology using a solution of polybutoxytitanium in isopropyl alcohol, followed by drying and annealing to convert titanium hydroxide into TiO_2 and increase the photosensitivity and adhesion of films [1].

The purpose of this work was to develop a similar method to obtain metal patterns using an aqueous tin dioxide sol for photoinduced reduction of palladium. This sol was obtained by hydrolysis of $SnCl_4 \cdot H_2O$ according to the method proposed in the work [2]. Then it was mixed with a solution of polyvinyl alcohol and applied to a glass by pouring, followed with drying at a temperature of 20 °C. After UV exposure through a stencil for several minutes, the samples were treated in a palladium chloride solution and then in a hypophosphite solution of chemical nickel plating. A shiny conductive nickel films were deposited on the exposed areas. In contrast to the process of obtaining patterns on TiO_2 films, multiple layer-by-layer deposition of SnO_2 films and their heating were not required.

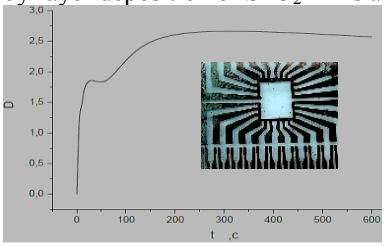

Fig. Dependence of nickel film optical density on the time of UV-exposition and the sample of conductive pattern

The ability of tin dioxide films to reduce palladium ions on their irradiated areas can be preserved for 24 hours and more instead of several seconds.

The Fig. shows the dependence of the optical density of nickel films on the duration of UV irradiation of the SnO_2 film with a mercury-quartz lamp, and a sample of a conductive nickel pattern obtained on the glass.

References

[1] V.V. Sviridov et al. Chemical Problems of the Development of New Materials and Technologies. Minsk : BSU (2003) 375 : 46.

[2] A.M. Maltanova, T.N. Vorobyova, S.K. Poznyak. Sviridov Readings: Collection of Papers (2013) 9 : 104.