DEPOSITION AND PROPERTIES OF TIN OXYCOMPOUND THIN FILMS OBTAINED FROM ORGANIC SOLS

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Tin dioxide films have found a wide application in optics, electronics, gas sensor production owing to such properties as semiconductivity, transparency in visible spectral range. The most often SnO_2 films are produced by sol-gel method and spray pyrolysis technique using aqueous and organic sols. Tin(II) hydroxochloride films are applied in the processes of electroless catalytic metal plating on dielectrics. This plating is possible owing to reduction of palladium ions with Sn(II) and palladium nanoparticles formation. The usage of tin(II) oxycompounds is of great interest for photoselective metal deposition. This process is based on photochemical sensitivity of Sn(II) hydroxochlorides which are easily oxidized with oxygen under irradiation. As a result, palladium catalyst does not appear on the irradiated parts of the samples and electroless plating provides the formation of positive conductive metal patterns.

The films on the base of Sn(II) hydroxochlorides are deposited from aqueous colloid solutions prepared by $SnCl_2$ regulated hydrolysis. Their lacks are the nonuniformity in thickness, polydispersity in grain sizes and unstability to oxidation at storage.

It is known, that films on the base of TiO_2 obtained by sol-gel method are used in photoresist-free technologies of negative conductive patterns manufacturing owing to their ability to produce electron-hole pairs under UV irradiation. Photoelectrons reduce adsorbed palladium ions with the Pd nanoparticles formation while photoholes are trapped by hole-accepting species. We suppose that photocatalytic activity can be also expected for SnO_2 and in the search of such SnO_2 application one have to consider that the properties of tin oxide films can be significantly regulated by varying the degree of stoichiometry and the Sn(II)/Sn(IV) ratio.

The purpose of this work was to find simple and universal method of thin tin oxide film production which is perspective to be used in microelectronic circuits and devices technologies and to provide the abilities to regulate film uniformity and fineness, to obtain negative and positive metal patterns with fine elements, to increase the sensitivity and spectral range of absorption.

Film-making organic sols were prepared by dissolution of $SnCl_2 \cdot 2H_2O$ in i-propanol or i-propanol-aceton media with a small quantity of water to provide the controlled $SnCl_2$ hydrolysis. Spin-coated one-layer films had a thickness of 8–16 nm that was easily increased to the desired value by repeated coating. The average surface roughness (R_a) was about 0.32 nm that is much better compared to Sn(II) hydroxochloride films obtained from aqueous solutions. The reduction ability of the films under investigation was confirmed by success in experiments on palladium activation and electroless nickel plating.

The films produced from organic sols appeared to be photosensitive. Depending on the solution composition, introduction of some additives and film storage it was possible to obtain positive or negative nickel patterns. This fact confirms that Sn-containing substances in such film can be oxidized in air in a process of photostimulated chemical oxidation and besides they reveal possibilities of charge carriers generation and their separation. That provides Pd nanoparticles formation on the irradiated sites of the films.

It was shown that the sign of Thomson voltage for obtained samples was negative that confirms n-type conductivity of the films. The measurements of conductivity value on alternating current with frequency 1 MHz revealed conductivity equal to $(0.8–1.4) \cdot 10^7$ S depending on their thickness. Samples are transparent in spectral range of 400–700 nm, and have a weak band of adsorbance at 900–1500. This adsorbance can be enlarged by doping of the films with Pd nanoparticles which are produced owing to reduction of $PdCl_2$ with Sn(II) containing compounds. These properties are of great interest in optoelectronics and the films obtained are prospective in different processes of solar energy transformation.