SYNTHESIS OF FILMS AND N-P-STRUCTURES BASED ON COPPER AND ZINC OXIDES USING MAGNETRON SPUTTERING

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Abstract

The results of obtaining zinc oxide films and *ZnO/Cu$_2$O(CuO)* heterojunctions are presented. Structural, optical and electrical properties of the samples were studied depending on synthesis conditions. *ZnO* films were grown by magnetron sputtering. The synthesized films with a thickness of about 0.3 micron had a resistivity of 0.0014 Ohm*cm, mobility of 4.5 cm^2/(V×s), free electron concentration of 1×10^{21} cm^{-3}, and a surface resistance of about 45 ohms per square. The optical transmission coefficient of *ZnO* films in the visible region was about 90%. Heterojunctions *n-ZnO/p-Cu$_2$O(CuO)* were obtained by vacuum deposition of copper on *ZnO* film followed by annealing. The effect of thermal annealing and plasma treatment on the properties of *ZnO/Cu$_2$O(CuO)* samples was investigated. The photoresponse of heterojunctions was found to be increased, and leakage current was reduced as a result of short-term treatment in a hydrogen plasma.

Key words: electrical conductivity of *ZnO* films; properties of zinc and copper oxides; magnetron sputtering method; synthesis; vacuum annealing; nanoparticles; nanostructures; crystallization.

Introduction

Recently, there has been an increasing interest in heterojunctions based on zinc and copper oxides, which is associated with the wide possibilities of their practical application, in particular for the creation of various types of detectors, photo- and optoelectronic devices [1-2]. Thus, high values of electrical conductivity of *ZnO* films and transparency in the visible range of the spectrum make it possible to produce transparent conductive electrodes for solar cells and other devices, various sensors and detectors, piezoelectric devices based on zinc oxide [3-6].

Experiment

Uniform *ZnO* films on glass substrates ~2×2 cm^2 were obtained from a ceramic ZnO target by DC magnetron sputtering. Previously, glass substrates were thoroughly cleaned by boiling in acetone, ethanol and washed with deionized water. Deposition of films was carried out in the argon atmosphere at a pressure of 10^{-3} atm, a voltage of 400V, a current of 200 mA, the substrate was at room temperature.

The surface morphology of the *ZnO* samples obtained by magnetron sputtering, were studied on a scanning electron microscope (SEM) Quanta 200i 3D (FEI). Optical transmission spectra of the obtained *ZnO* films were measured using Lambda-35 spectrophotometer (PerkinElmer). The electrical parameters of the *ZnO* films were determined by measuring the specific resistance and carrier concentration by the Hall effect in the van der Pau configuration by a four-probe method at room temperature using the HMS-3000 (Ecopia) unit with a 0.55 T magnetostatic magnet. The current-voltage curves of obtained structures were measured by the Elins P-30J potentiostat in a two-electrode circuit using clamping gold contacts.

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