Semiconductors 2016 vol.50 N1, pages 43-49

Structure and optical properties of ZnO with silver nanoparticles

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Abstract

© 2016, Pleiades Publishing, Ltd.Textured nanocrystalline ZnO thin films are synthesized by ion beam assisted deposition. According to X-ray diffraction data, the crystallite size is ~25 nm. Thin (~15 nm) ZnO layers containing Ag nanoparticles are formed in a thin surface region of the films by the implantation of Ag ions with an energy of 30 keV and a dose in the range (0.25–1) × 1017 ion/cm2. The structure and optical properties of the layers are studied. Histograms of the size distribution of Ag nanoparticles are obtained. The average size of the Ag nanoparticles varies from 0.5 to 1.5–2 nm depending on the Ag-ion implantation dose. The optical transmittance of the samples in the visible and ultraviolet regions increases, as the implantation dose is increased. The spectra of the absorption coefficient of the implanted films are calculated in the context of the (absorbing film)/(transparent substrate) model. It is found that the main changes in the optical-density spectra occur in the region of ~380 nm, in which the major contribution to absorption is made by Ag nanoparticles smaller than 0.75 nm in diameter. In this spectral region, absorption gradually decreases, as the Ag-ion irradiation dose is increased. This is attributed to an increase in the average size of the Ag nanoparticles. It is established that the broad surface-plasmon-resonance absorption bands typical of nanocomposite ZnO films with Ag nanoparticles synthesized by ion implantation are defined by the fact that the size of the nanoparticles formed does not exceed 1.5–2 nm.

http://dx.doi.org/10.1134/S1063782616010139