Journal of Physics: Conference Series 2014 vol.572 N1

Optical and electrical studies of ZnO thin films heavily implanted with silver ions

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Abstract

© Published under licence by IOP Publishing Ltd. Thin films of zinc oxide (ZnO) with the thickness of 200 nm have been deposited on quartz substrates by using ion-beam sputtering technique. Then Ag+ ions with the energy of 30 keV have been implanted into as-deposited ZnO films to the fluences in the range of (0.25-1.00)×1017 ions/cm2 to form ZnO:Ag composite layers with different concentrations of the silver impurity. The analysis of the microstructure has shown that the thickness of the ZnO film decreases, and the Ag dopant concentration tends to the saturation with increasing Ag implantation fluence. The ZnO:Ag composite layers reveal the optical selective absorption at the wavelength of the surface plasmon resonance that is typical for silver nanoparticles dispersed in the ZnO matrix. The red shift of the plasmon resonance peak from 480 to 500 nm is observed with the increase in the implantation fluence to 0.75×1017 Ag ions/cm2. Then the absorption peak position starts the backward motion, and the absorption intensity decreases with the subsequent increase in the implantation fluence. The non-monotonic dependence of the absorption peak position on the implantation fluence has been analyzed within of Maxwell Garnet theory and taking into account the strong sputtering of ZnO films during implantation. The ZnO:Ag composite layers exhibit the p-type conductivity indicating that a part of Ag+ ions is in the form of acceptor impurities implanted into the ZnO lattice.

http://dx.doi.org/10.1088/1742-6596/572/1/012022