X−Ray Absorption Spectroscopic Study of 120 MeV Ag$^{9+}$ Ion−Irradiated N−Doped ZnO Thin Films

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We report the electronic structure modification in the swift heavy ion (SHI) irradiated N-doped ZnO thin films prepared by RF sputtering from ZnO target in different ratio of Ar/N$_2$ gas mixture using highly pure N$_2$ gas. The different N-ZnO thin films were then irradiated with 120 MeV Ag ion beam with different doses ranging from $1\times10^{11}$ to $5\times10^{12}$ ions/cm$^2$ and characterized by XRD and near edge X-ray absorption ne structure (NEXAFS) at N and O K-edges. The NEXAFS measurements provide direct evidence of O 2p and Zn 3d orbital hybridization and also the bonding of N ions with Zn and O ions. The minimum value of resistivity of 790 $\Omega$cm, a Hall mobility of 22 cm$^2$V$^{-1}$s$^{-1}$ and the carrier concentration of $3.6\times10^{14}$ cm$^{-3}$ were yielded at 75% N$_2$. X-ray diffraction (XRD) measurements revealed that N-doped ZnO films had the preferential orientation of (002) plane for all samples, while crystallinity start decreasing at 32.5% N$_2$. The average crystallite size varies from 5.7 to 8.2 nm for 75% and then decreases to 7.8 nm for 80% Ar:N$_2$ ratio.

**Keywords:** N-doped ZnO thin film, Swift heavy ion irradiation, X-ray absorption spectroscopy, RF magnetron sputtering