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# A Study on Thermal Stability of Ga-doped ZnO Thin Films with a $TiO_2$ Barrier Layer

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Ga-doped ZnO (GZO) was substitutes of the $SnO_2$:F films on soda lime glass substrate in the photovoltaic devices such as CIGS, CdTe and DSSC due to good properties and low cost. However, it was reported that the electrical resistivity of GZO is unstable above 300°C in air atmosphere. To improve thermal stability of GZO thin films at high temperature above 300°C an $TiO_2$ thin film was deposited on the top of GZO thin films as a barrier layer by Pulsed Laser Deposition (PLD) method. $TiO_2$ thin films were deposited at various thicknesses from 25 nm to 100 nm. Subsequently, these films were annealed at temperature of 300°C, 400°C, 500°C in air atmosphere for 20 min. The XRD measurement results showed all the films had a preferentially oriented ( 0 0 2 ) peak, and the intensity of ( 0 0 2 ) peak nearly did not change both GZO (300 nm) single layer and $TiO_2$ (50 nm)/GZO (300 nm) double layer. The resistivity of GZO (300 nm) single layer increased from $7.6\times10^{-4}$ Ωm (RT) to $7.7\times10^{-2}$ Ωm (500°C). However, in the case of the $TiO_2$ (50 nm)/GZO (300 nm) double layer, resistivity showed small change from $7.9\times10^{-4}$ Ωm (RT) to $5.2\times10^{-3}$ Ωm (500°C). Meanwhile, the average transmittance of all the films exceeded 80% in the visible spectrum, which suggests that these films will be suitable for photovoltaic devices.

**Keywords:** Ga-doped ZnO, GZO, TiO2, Barrier layer, Thin film, Pulsed laser deposition, PLD

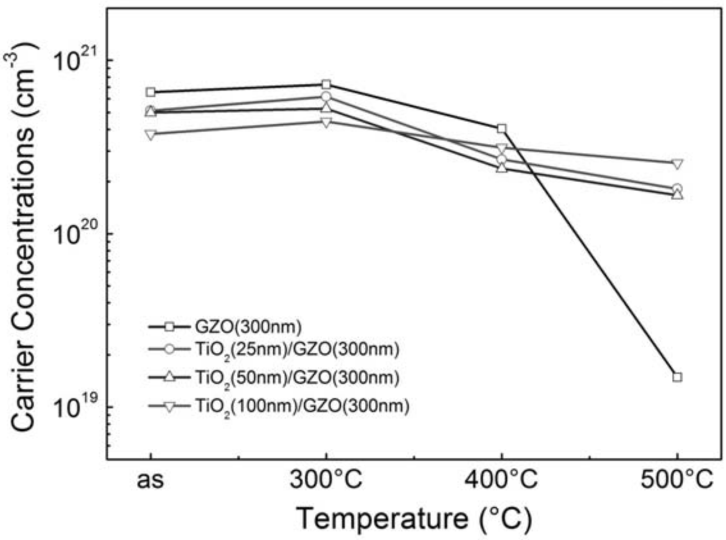


**Fig. 1.** Carrier Concentrations of GZO thin films with a $TiO_2$ barrier layer under different post-annealing temperatures.

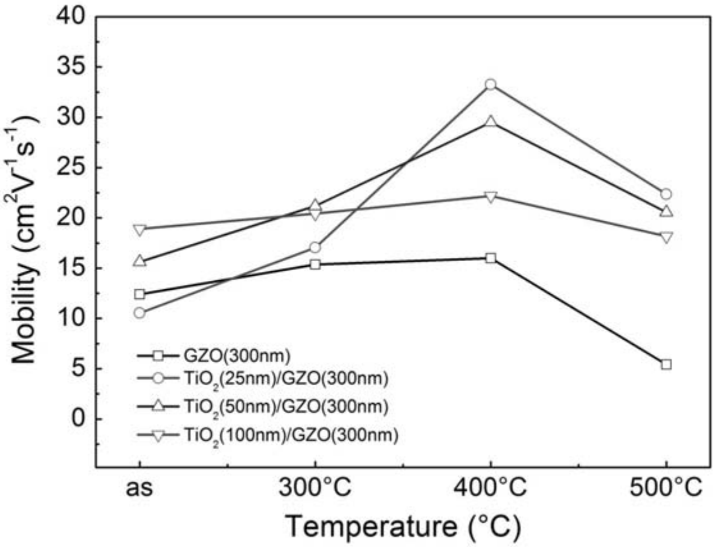


**Fig. 2.** Hole Mobility of GZO thin films with a TiOz barrier layer under different post-annealing tempreatures.

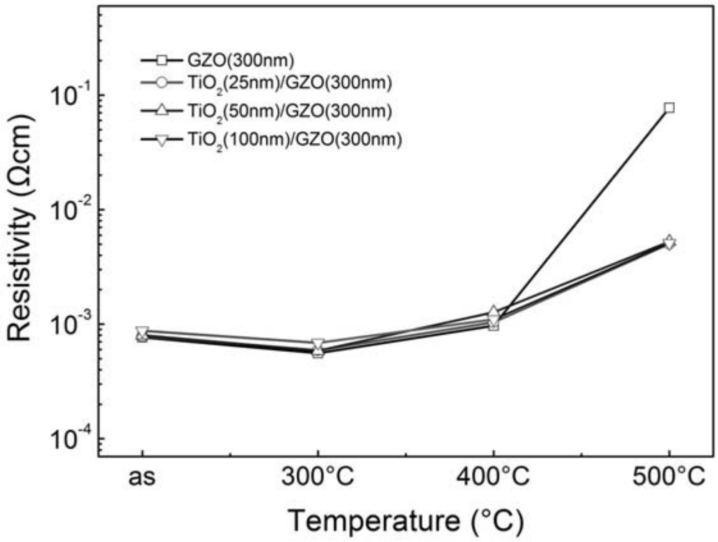


**Fig. 3.** Resistivity of GZO thin films with a $TiO_2$ barrier layer under different post-annealing temperatures.