

Table 2.1: Variation in Schottky barrier height values based on ZnO measured by different techniques.

Metal	SBH (eV)	Measurement Technique	Deposition Technique	Ref
Pd	0.74	I-V	Vacuum deposition	[0]
Pd	0.784	I-V	Resistive evaporation	[0]
Pd	0.67, 0.67	I-V, H(I) I	Thermal evaporation	[0]
Au	0.59, 0.61	I-V, C-V	Resistive evaporation	[0]
Au	0.70, 0.73	I-V, C-V	DC magnetron sputtering	[0]
Au	0.61, 0.92	I-V, C-V	e-beam deposition	[0]
Ag	0.70, 0.76, 0.68	lnI-V, H(I)-I, F(V)-V	RF sputtering	[0]
Ag	0.89 and 0.92	I-V, C-V	e-beam deposition	[0]
Ag	0.85, 1.68	I-V, C-V	RF sputtering	[0]
Pt	0.65, 0.74, 0.80	I-V	e-beam deposition	[0]
Pt	0.66, 0.41	I-V, H(I)-I	Sputtering	[0]
Ir	0.837, 0.837, 0.924	I-V, F(V)-V, C-V	e-beam deposition	[0]

Table 4.1: Structural and lattice parameters of ZnO thin films

FWHM	2θ		D (nm)	δ (nm) ⁻²	Lattice constants (Å)		Lattice constants (Å) from (JCPDS)		Band gap (eV)
(002)	(100)	(002)	(002)	(002)	a (100)	c (002)	a	c	
0.181	31.805	34.477	48	0.0004	3.246	5.198	3.253	5.213	3.23

Table 4.2: The Schottky diode parameters from I - V and C - V measurements before and after irradiation.

Events	SBH (eV)		Ideality	Saturation current, I_s		Series	N_D (cm ⁻³)
	I - V	C - V	Factor (n)	(A) $\times 10^{-9}$		Resistance (Ω)	$\times 10^{17}$
Before irradiation	0.635	1.24	3.41	11.2		53	12
After irradiation	0.536	1.18	3.48	519		43	4.0

Table 4.3: The defect energy E_T below conduction band and the apparent capture cross-section σ_{ap} of defects in ZnO thin films deposited on the n-Si substrate.

Defect label	E_T (eV)	σ_{ap} (cm ²)
E_4	0.41	4.8×10^{-16}
E_a	0.35	5.7×10^{-17}
E_{a1}	0.53	7.7×10^{-14}
E_{a2}	0.36	2.3×10^{-16}

Table 4.4: Structural and lattice parameters of undoped and doped ZnO thin films.

Plane	FWHM	2θ		D (nm)	$\delta \times 10^{-4}$ (nm) ⁻²	Lattice constants (Å)		c/a
	(002)	(100)	(002)	(002)	(002)	$a(100)$	c (002)	
Undoped ZnO	0.196	31.874	34.514	42	5.6	3.242	5.197	1.603
Er	0.161	31.831	34.472	51	3.8	3.246	5.203	1.603
Yb	0.152	31.831	34.485	54	3.4	3.246	5.201	1.602
JCPDS 76-0704		31.762	34.406			3.253	5.213	1.603

Table 4.5: Schottky diodes parameters from I - V measurements at room temperature.

Sample	SBH (eV)	Ideality Factor	Saturation current, I_s (A)	Leakage current (A) at -1 V	Series Resistance(KΩ)
Undoped ZnO	0.730	2.69	5.0×10^{-6}	9.0×10^{-5}	0.20
Er	0.688	2.24	1.41×10^{-9}	6.0×10^{-8}	2.0
Yb	0.977	1.82	333×10^{-12}	1.5×10^{-8}	3.0

Table 4.6: The Schottky diodes parameters from I - V and C - V measurements in the temperature range of 50 - 290 K.

T (K)	Pd/Er-doped ZnO thin films				Pd/Yb-doped ZnO thin films			
	SBH (eV)		Ideality Factor, n	N_D (cm ⁻³)(C - V) $\times 10^{14}$	SBH (eV)		Ideality Factor, n	N_D (cm ⁻³)(C - V) $\times 10^{14}$
	I - V	C - V			I - V	C - V		
50	0.286	2.13	2.935	2.60	0.511	1.75	1.746	2.68
90	0.353	1.82	2.716	2.47	0.684	1.28	1.307	2.47
130	0.414	1.59	2.596	2.32	0.721	1.13	1.288	2.46
170	0.479	1.31	2.467	2.25	0.756	1.07	1.272	2.42
210	0.541	1.25	2.463	2.24	0.772	1.0	1.30	2.40
250	0.631	1.17	2.401	2.22	0.779	0.94	1.382	2.39
290	0.664	1.09	2.465	2.21	0.80	0.93	1.418	2.34

Table 4.7: The electronic properties of defects in Er-doped and Yb-doped ZnO thin films deposited on the n-Si substrate.

Sample	Defect label	E_T (eV)	σ_{ap} (cm ²)Er-
doped ZnO	E _{0.41}	0.41	4×10^{-16}
Yb-doped ZnO	E _{0.54}	0.54	4×10^{-15}

Table 4.8: Structural and lattice parameters of undoped and Er-doped ZnO thin films

Sample	FWHM	2θ	D (nm)	$\delta \times 10^{-4}$ (nm) ⁻²	Lattice constants (Å)		c/a	Band gap (eV)
Er at. %	(002)	(002)	(002)	(002)	$a(100)$	$c(002)$		
0	0.254	34.469	32	9.8	3.245	5.204	1.604	3.024
2	0.686	34.397	12	69.4	3.242	5.214	1.608	3.073
4	0.903	34.395	09	123.5	3.238	5.215	1.610	3.091
6	1.016	34.377	08	156.3	3.238	5.218	1.611	3.157

Table 4.9: The Schottky diode parameters obtained from I - V and C - V measurements at room temperature.

Sample	SBH (eV)		Ideality	Saturation current, I_s		Series	N_D	Degree of rectification
Er at. %	I - V	C - V	Factor	$\times 10^{-9}$ (A)		Resistance(Ω)	($\times 10^{15}$ cm ⁻³)	(orders of magnitude)
0	0.65	0.89	2.16	18.25		67	1.77	3
2	0.74	1.0	1.12	0.872		99	5.89	5
4	0.71	1.62	1.79	1.25		43	0.75	5
6	0.72	1.88	1.37	0.410		60	1.72	5

Table 4.10: The Schottky diode leakage current under reverse bias at -2 V under the dark and illumination from I - V measurements.

Sample	leakage current (A)	
Er at. %	under light	under dark
0	2.23×10^{-4}	2.01×10^{-6}
2	3.81×10^{-4}	9.46×10^{-7}
4	1.94×10^{-4}	2.72×10^{-7}
6	3.40×10^{-4}	2.10×10^{-6}

Table 4.11: The electronic properties of defects in Er-doped ZnO and Yb-doped ZnO thin films deposited on the n-Si substrate.

Sample Er at. %	Defect label	$E_T(eV)$	$\sigma_{ap} (cm^2)$
0	E_4	0.44	8×10^{-16}
	E_5	0.76	6×10^{-12}
2	E_4	0.37	3×10^{-17}
4	E_4	0.42	6×10^{-16}
		0.33	2×10^{-17}
		0.45	1.4×10^{-14}
		0.54	3×10^{-14}
	E_5	0.69	2×10^{-11}
		0.55	6×10^{-14}
6	E_5	0.66	2×10^{-12}

Table 4.12: Structural, lattice parameters and optical band gap of Er and Yb co-doped ZnO thin films

Sample (Er, Yb) at. %	FWHM (002)	2θ (002)	D (nm) (002)	$\delta \times 10^{-3} (nm)^{-2}$ (002)	Lattice constants (\AA) $a(100)$ $c(002)$		c/a	Band gap (eV)
0	0.336	35.243	26	1.5	3.171	5.093	1.606	3.22
2	0.749	35.150	12	6.9	3.168	5.106	1.612	3.15
4	0.828	35.074	10	10	3.172	5.117	1.613	3.19
6	1.302	35.075	07	20.4	3.169	5.117	1.615	3.20

Table 4.13: The Schottky diode parameters determined from I - V and C - V measurements, measured at room temperature.

Sample (Er, Yb) at. %	SBH (eV) I - V C - V		Ideality Factor	Saturation current, I_s $\times 10^{-9}$ (A)	Series Resistance(Ω)	N_D (cm^{-3})	Degree of rectification (orders of magnitude)
0	0.54	0.55	3.85	450	364	2.7×10^{17}	1.5
2	0.67	1.97	1.82	2.02	106	4.3×10^{15}	4
4	0.68	1.49	1.78	2.11	95	5.2×10^{15}	6
6	0.67	0.67	1.12	2.19	115	7.0×10^{15}	5