

Table S1. Relative atomic ratios of In, O, and Sn for the ITO films with different SnO₂ cycle ratios.

SnO ₂ cycle ratio (%)	Relative atomic ratio (%)		
	In	Sn	O
2.5	39.9	1.0	59.1
5.0	38.9	1.6	59.5
7.5	38.3	2.3	59.3
10.0	37.3	3.3	59.4
15.0	36.5	4.2	59.3
20.0	35.4	5.8	58.9

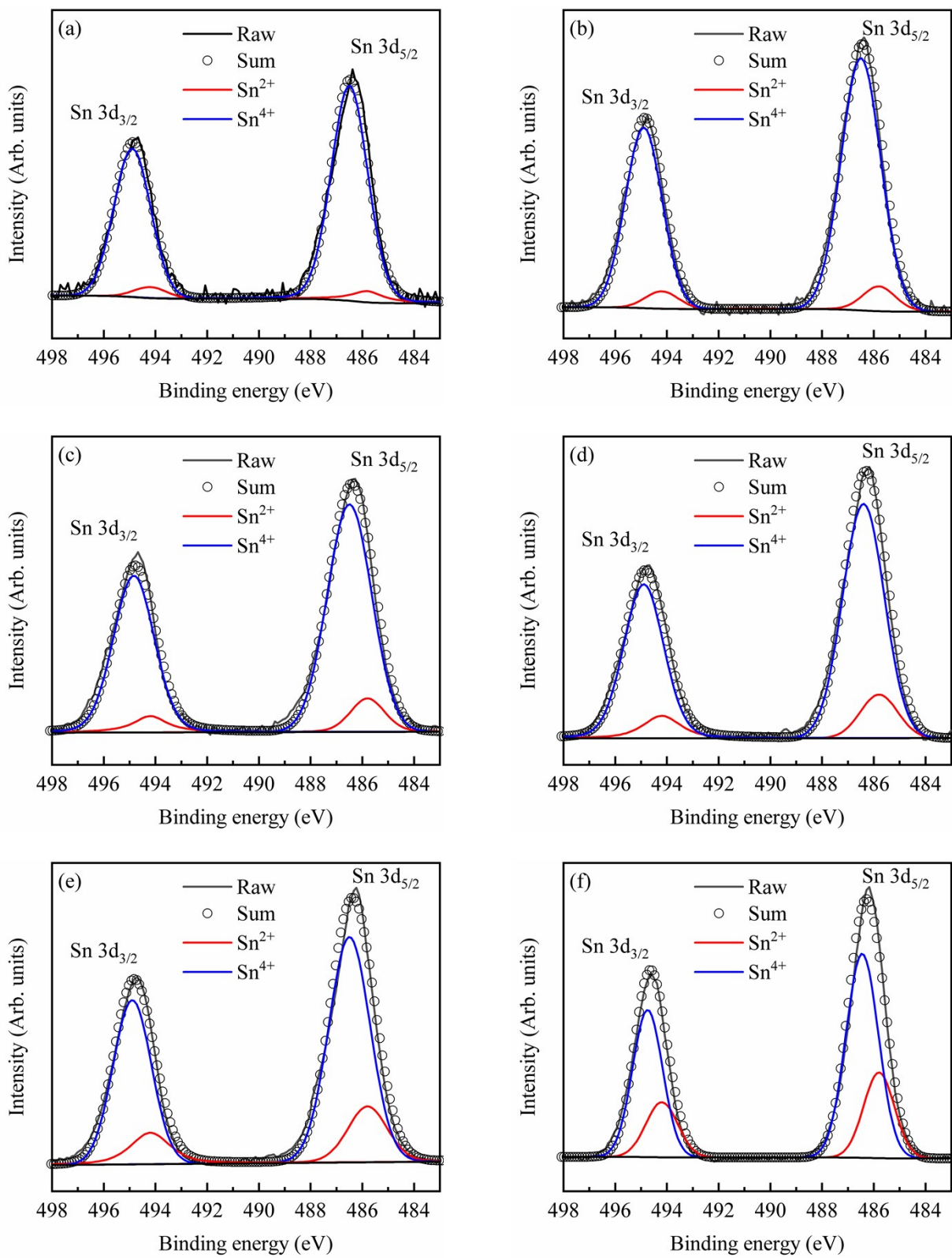


Figure S1. Deconvoluted Sn 3d XPS spectra for the ITO films with SnO₂ cycle ratios of (a) 2.5%, (b) 5%, (c) 7.5%, (d) 10%, (e) 15%, and (f) 20%.

Table S2. Peak areas of Sn⁴⁺ and Sn²⁺ components for the ITO films with different SnO₂ cycle ratios.

SnO ₂ cycle (%)	Peak area				Sn ⁴⁺ /(Sn ²⁺ +Sn ⁴⁺) ratio (%)
	Sn ⁴⁺ 3d _{5/2}	Sn ⁴⁺ 3d _{3/2}	Sn ²⁺ 3d _{5/2}	Sn ²⁺ 3d _{3/2}	
2.5	48449.96	32299.97	3208.44	2138.96	93.79
5	88311.62	58874.41	5975.34	3983.56	93.66
7.5	142127.72	94751.81	17235.50	11490.33	89.18
10	166091.55	110727.70	27641.51	18427.67	85.73
15	230015.85	153343.90	57174.21	38116.14	80.09
20	195791.55	130527.70	77769.39	51846.26	71.57

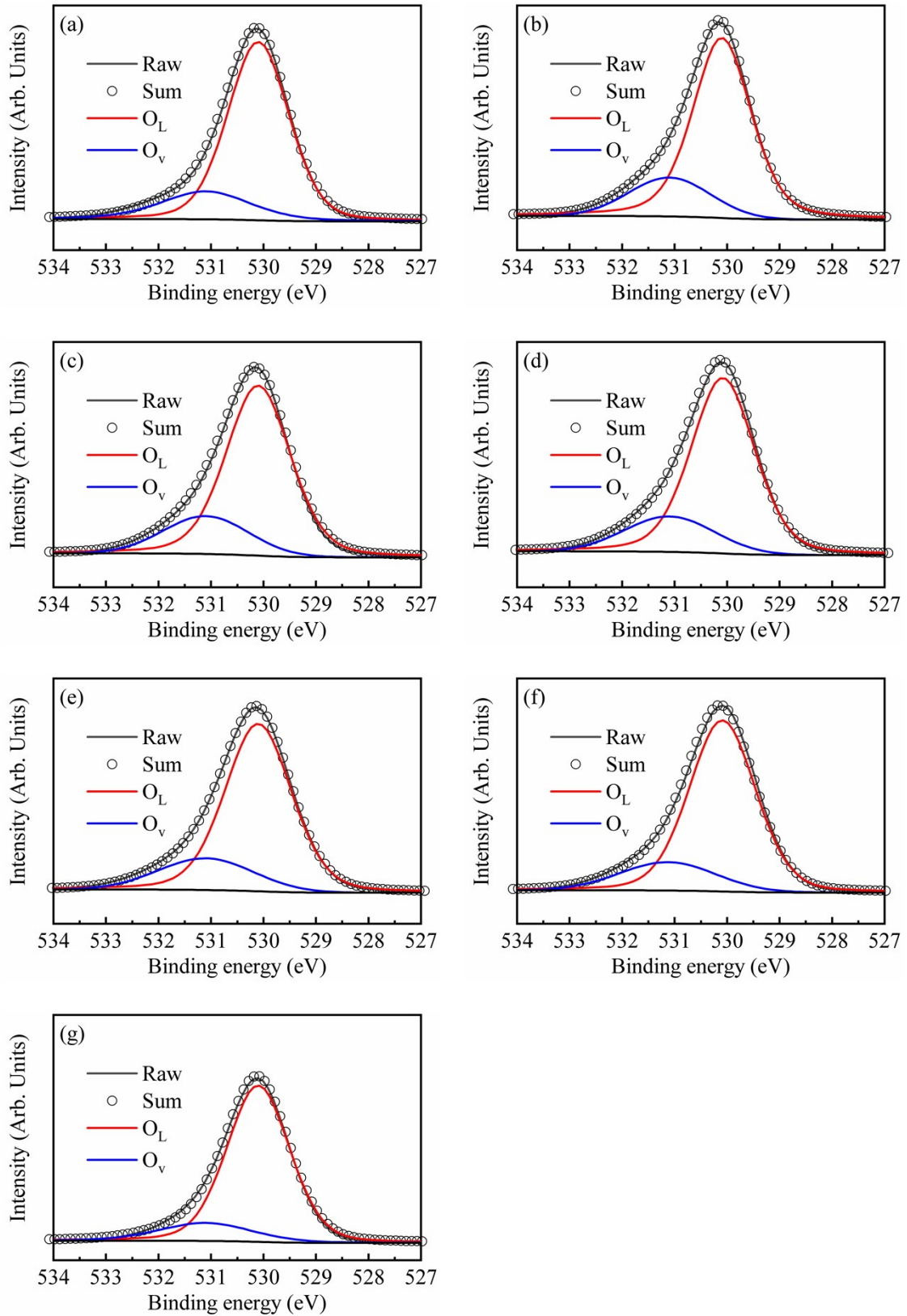


Figure S2. Deconvoluted O 1s spectra for the ITO films with SnO₂ cycle ratios of (a) 0%, (b) 2.5%, (c) 5%, (d) 7.5%, (e) 10%, (f) 15%, and (g) 20%.

Table S3. Peak areas of O_v and O_L components for the ITO films with different SnO_2 cycle ratios.

SnO ₂ cycle ratio (%)	Peak area		$O_v/(O_L+O_v)$ (%)
	O_v	O_L	
0	92986.09	378760.2	19.71
2.5	100702.01	388411.4	20.59
5	103090.5	389505.2	20.93
7.5	100164.8	397724.5	20.12
10	95698.78	391809.7	19.63
15	85066.9	392621.5	17.81
20	58604.73	339531.1	14.72

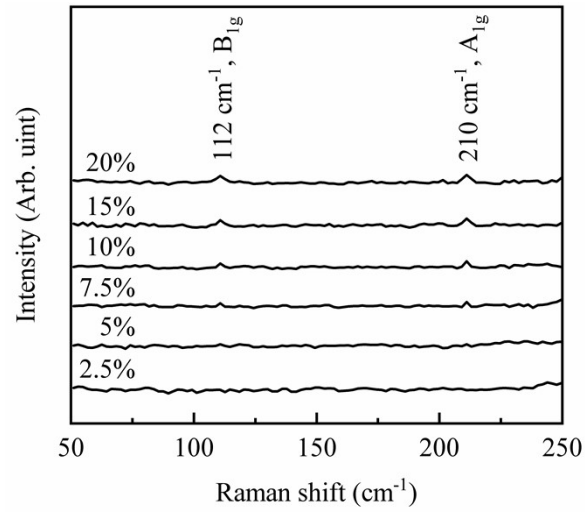


Figure S3. Raman spectra of the ITO samples with different SnO₂ cycle ratios.