

Table S1 Comparison of PD-L1 TPS scores between single-stained and dual-stained specimens in MPE cytopathology and histopathology

Method	PD-L1 expression TPS score			P value
	<1%	1–49%	≥50%	
Cytopathology				0.12
Single-stained	45	50	17	
Dual-stained	59	36	17	
Histopathology				0.89
Single-stained	67	29	16	
Dual-stained	70	26	16	

PD-L1, programmed death-ligand 1.

Table S2 Detailed information of discordant cases for PD-L1 expression TPS scores in two pathological specimens among different stain methods

No.	Type	Sample type	Sample origin	Tumor fraction	Single-stained	Dual-stained
1	Cytopathology			<0.5	>1%	<1%
2	Cytopathology			<0.5	>1%	<1%
3	Cytopathology			<0.5	>1%	<1%
4	Cytopathology			<0.5	>1%	<1%
5	Cytopathology			<0.5	>1%	<1%
6	Cytopathology			<0.5	>1%	<1%
7	Cytopathology			≥0.5	>40%	50%
8	Cytopathology			<0.5	>50%	30%
9	Cytopathology			<0.5	>50%	40%
10	Cytopathology			<0.5	3%	<1%
11	Cytopathology			<0.5	5%	<1%
12	Cytopathology			<0.5	5%	<1%
13	Cytopathology			<0.5	5%	<1%
14	Cytopathology			<0.5	5%	<1%
15	Cytopathology			<0.5	5%	<1%
16	Cytopathology			≥0.5	40%~50%	50%
17	Cytopathology			<0.5	5%~10%	<1%
18	Cytopathology			<0.5	5%	<1%
19	Histopathology	Biopsy	Lung		2%	<1%
20	Histopathology	Biopsy	Lung		<5%	<1%
21	Histopathology	Biopsy	Pleura		>1%	<1%

PD-L1, programmed death-ligand 1. Tumor fraction refers to the ratio of tumor cells to non-tumor cells in MPE cytopathology slides, where non-tumor cells include histiocytes, mesothelial cells, and inflammatory cells, etc.

Table S3 Concordance of PD-L1 expression in single-stained and dual-stained MPE cytopathology specimens versus matched single-stained histopathology specimens under low tumor density

Histopathology single-stained	Cytopathology single-stained (Tumor fraction <0.5)					Cytopathology dual-stained (Tumor fraction <0.5)				
	<1%	1–49%	≥50%	kappa	P	<1%	1–49%	≥50%	kappa	P
<1%	13	19	0	0.47	<0.001	26	6	0	0.78	<0.001
1–49%	0	10	3			1	11	1		
≥50%	0	0	6			0	0	6		

Tumor fraction refers to the ratio of tumor cells to non-tumor cells in MPE cytopathology slides, where non-tumor cells include histiocytes, mesothelial cells, and inflammatory cells, etc.

Table S4 Concordance of PD-L1 expression in single-stained and dual-stained MPE cytopathology specimens versus matched single-stained histopathology specimens under high tumor density

Histopathology single-stained	Cytopathology single-stained (Tumor fraction ≥0.5)					Cytopathology dual-stained (Tumor fraction ≥0.5)				
	<1%	1–49%	≥50%	kappa	P	<1%	1–49%	≥50%	kappa	P
<1%	29	5	1	0.72	<0.001	29	5	1	0.72	<0.001
1–49%	3	13	0			3	12	1		
≥50%	0	3	7			0	2	8		

Tumor fraction refers to the ratio of tumor cells to non-tumor cells in MPE cytopathology slides, where non-tumor cells include histiocytes, mesothelial cells, and inflammatory cells, etc.

Table S5 Concordance of PD-L1 expression TPS in different histological sample types and source with dual-stained MPE cytopathology specimens

Histopathology single-stained	Cytology PD-L1/TTF-1 dual-stained			kappa	P
	<1%	1–49%	≥50%		
Resection samples					
<1%	16	2	0	0.91	<0.001
1–49%	0	8	1		
≥50%	0	0	4		
Biopsy Sample					
<1%	39	9	1	0.77	<0.001
1–49%	4	15	1		
≥50%	0	2	10		
Primary Tumor					
<1%	18	7	1	0.70	<0.001
1–49%	2	10	1		
≥50%	0	1	6		
Metastatic Tumor					
<1%	37	4	0	0.88	<0.001
1–49%	2	13	1		
≥50%	0	1	8		

PD-L1, programmed death-ligand 1; TTF-1, thyroid transcription factor 1.

Table S6 Correlation between PD-L1/TTF-1 double-stained in cytopathological specimens and the clinical characteristics of patients

Variable	Cytology PD-L1/TTF-1, n (%)			P value
	<1%	1–49%	≥50%	
Sex				0.98
Male	30 (51.7%)	19 (32.8%)	9 (15.5%)	
Female	29 (53.7%)	17 (31.5%)	8 (14.8%)	
Age (years)				0.59
Median	67	67	67	
Range	34-83	40-81	48-84	
Smoking History				0.19
Yes	24 (48.0%)	15 (30.0%)	11 (22.0%)	
No	35 (56.5%)	21 (33.9%)	6 (9.7%)	
Sample Type				0.98
Resection	16 (51.6%)	10 (32.3%)	5 (16.1%)	
Small Biopsy	43 (53.1%)	26 (32.1%)	12 (14.8%)	
Sample source				0.53
Lung	20 (43.5%)	18 (39.1%)	8 (17.4%)	
Lymph Node	15 (65.2%)	5 (21.7%)	3 (13.0%)	
Pleura	24 (55.8%)	13 (30.2%)	6 (14.0%)	
Tumor Type				0.26
Primary	20 (43.5%)	18 (39.1%)	8 (17.4%)	
Metastasis	39 (59.1%)	18 (27.3%)	9 (13.6%)	
Genetics				<0.001
EGFR mutations	41 (69.5%)	14 (23.7%)	4 (6.8%)	
No mutations	18 (34.0%)	22 (41.5%)	13 (24.5%)	
Tumor fraction				0.72
<0.5	24 (54.5%)	15 (34.1%)	5 (11.4%)	
≥0.5	35 (51.5%)	21 (30.9%)	12 (17.6%)	

PD-L1, programmed death-ligand 1; TTF-1, thyroid transcription factor 1; EGFR, epidermal growth factor receptor.

Table S7 The distribution of VTC >100 across in selected cytopathological specimens among different submission groups

Submission	VTC >100, n (%)			Total
	2	3	4	
4	2 (33.3)	4 (66.7)	0(0)	6
3	42 (39.6)	64(60.4)	0(0)	106