

Deployment in Chemical Vapor Deposition Applications

Table 1: Chemical Vapor Deposition Target

Target Type	MFL (Ours)	Ideal Target
Film thickness (center) [nm]	1047.5	(100, 2000)
Film thickness (edge) [nm]	1147.3	(100, 2200)
Internal stress [MPa]	0.0	0.047
Surface roughness (Ra) [nm]	5.148	(0.1, 10)

Table 2: Chemical Vapor Deposition Input

Input Type	MFL (Ours)	Input Constraints
SiH ₄ flow rate [sccm]	317.0320	(50, 500)
NH ₃ flow rate [sccm]	560.5539	(100, 1000)
N ₂ flow rate [sccm]	1288.5685	(200, 2000)
Chamber temperature [°C]	541.5430	(300, 750)
Chamber pressure [Torr]	5.1651	(1, 10)
Chamber humidity [%RH]	24.6166	(5, 40)
Electrode distance [mm]	16.7863	(10, 30)
Pre-clean plasma power [W]	146.6214	(0, 300)
Pre-clean duration [s]	36.2421	(0, 60)
Wafer rotation speed [rpm]	1906.4441	(0, 3000)
Process time [s]	5.05	144.5516

Deployment in Wire Bonding Applications

Table 3: Wire Bonding Target

Target Type	MFL (Ours)	Ideal Target
Pull strength [gf]	15.005	(5, 25)
Bonding x-offset [μm]	-0.0001	(-20, 20)
Bonding y-offset [μm]	-0.0002	(-20, 20)

Table 4: Table 4: Wire Bonding Input

Input Type	MFL (Ours)	Input Constraints
Bonding pressure [gf]	98.6096	(20, 120)
Bonding time [ms]	19.9200	(1, 30)
Temperature [°C]	240.9897	(100, 300)
Wire diameter [μm]	28.0635	(15, 33)
Wire length [mm]	3.2536	(0.5, 5.0)
Pad diameter [μm]	88.7107	(50, 150)

Ablation Experiments

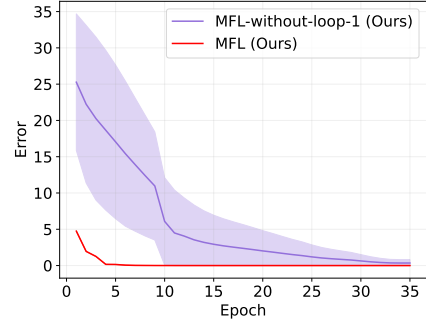


Figure 1: Ablation experiments: comparison between MFL and MFL without loop 1 training.

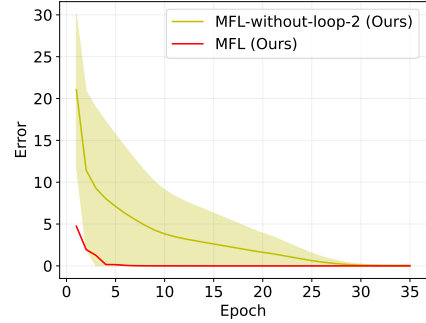


Figure 2: Ablation experiments: comparison between MFL and MFL without loop 2 training.

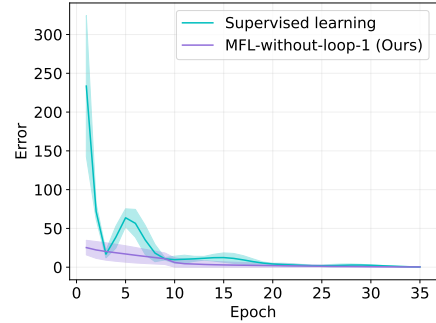


Figure 3: Ablation experiments: comparison between MFL without loop 1 training and supervised learning.