

Taguchi Design of Experiment Enabling the Reduction of Spikes on the Sides of Patterned Thin Films for Tunnel Junction Fabrication

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Table S1. Levels assigned to the four photolithography parameters for the Taguchi Design of Experiment.

Parameter	Level 1	Level 2	Level 3
Spin Coating Speed (rpm)	2000	3000	4000
Soft Baking Temperature (^o C)	80	90	100
Developer Soaking Time (sec)	40	60	80
UV Exposure Time (sec)	15	20	25

Calculating S/N ratio for Taguchi Design of Experiment for smaller the better criteria:

Table S2. *L9 experiments for the bottom layer optimization. The last two columns indicate name and magnitude of the experimental results.*

Experiment Number	Spin Speed (rpm)	Baking Temperature (°C)	Pre-soak Time (sec)	UV Exposure Time (sec)
1	2000	80	40	15
2	2000	90	60	20
3	2000	100	80	25
4	3000	80	60	25
5	3000	90	80	15
6	3000	100	40	20
7	4000	80	80	20
8	4000	90	40	25
9	4000	100	60	15

The signal to noise ratio was calculated by utilizing raw AFM data according to the method published elsewhere [10]. The S/N ratio expression for the smaller the better criteria is the following:

$$S/N \text{ ratio} = -10 \log \sum_{i=1}^n \frac{y_i^2}{n}$$

Here, y_i are individual experimental data, and n is the total number of data points collected for each experiment.

The signal to noise ratio was calculated by using the height of notches above the thickness of the film.

Table S3: AFM thickness measurement provided the notch height above the film thickness.

Experiment Number	y ₁ (nm)	y ₂ (nm)	y ₃ (nm)	y ₄ (nm)	S/N ratio Based on AFM data
1	71	67.2	100	95.7	-38.136
2	98	92	57.03	28.02	-38.517
3	89.21	17.06	62	36	-38.289
4	1.5	0.2	1.5	1.3	-19.905
5	105.6	0.7	85.8	42.6	-37.912
6	12.18	47.5	18.6	25.23	-22.304
7	55.49	49.77	25.34	28.54	-33.086
8	86.32	76.85	8.45	34.76	-36.51
9	5.86	0	0.1	12.52	-10.59

Table S4: Degree of interaction between two factors is determined by the percent severity index (SI).

Interacting variables	SI(%)
Pre-soak time x UV exposure time	65.47
Spin speed x Baking Temp.	25.97
Spin speed x UV exposure time	17.38
Baking Temp. x Pre-soak time	16.73
Spin x Pre-soak time	12.04
Baking Temp. x UV Exposure Time	4.18

Table S5 ANOVA analysis showing impact of individual parameter.

Factors	<i>P</i> (%)
Spin speed	25.77
Baking Temp.	38.77
Pre-soak time	31.92
UV Exposure time	3.54