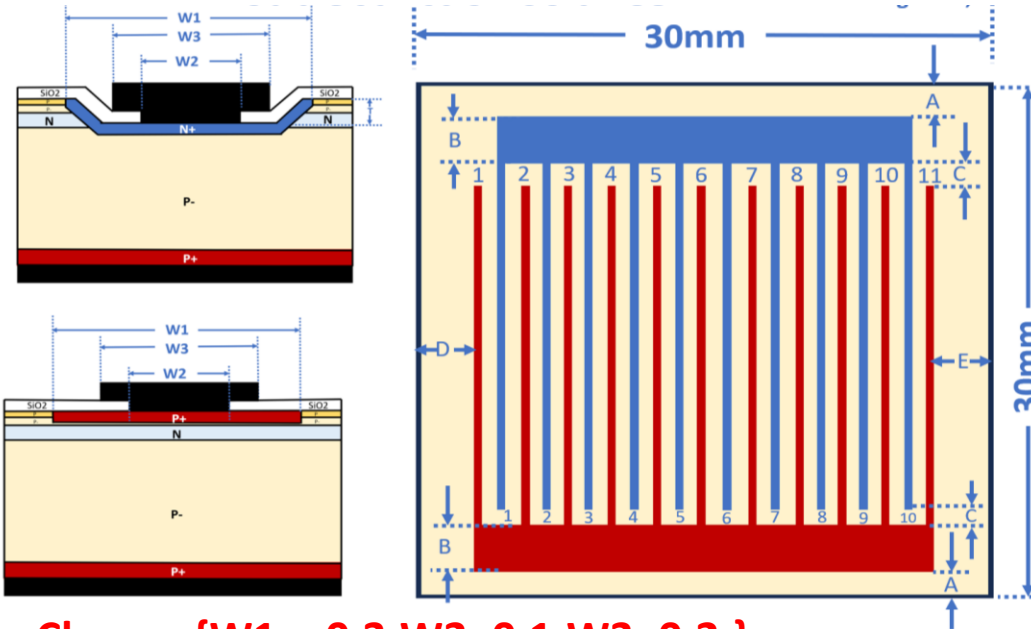


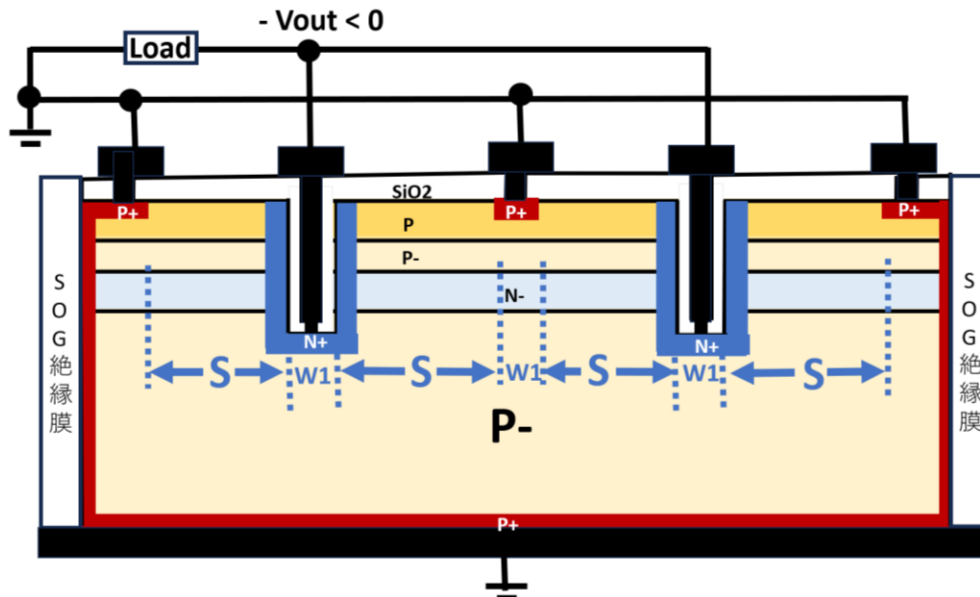
PP-N-P-P+ Double Junction Solar Cell

Yoshiaki Hagiwara, AIPS

2026年10月30日0740am現在



Choose {W1 = 0.3; W2 = 0.1; W3 = 0.2;}



MASK01 Silicon KOH Etching and N+ Diffusion

MASK02 P+ Diffusion

MASK03 Contact Window

MASK04 Metal Wiring

Line Length (L) :

$$30 = 2 (A + B) - C + L ;$$

$$L = 30 - 2 (A + B) - C ;$$

Choose A=B=C=1.

We have L = 25.

Line Spacing (S) :

$$30 = D + E + 21 * W1 + 20 * S ;$$

$$S = (30 - D - E - 21 * W1) / 20 ;$$

$$D + E = 30 - 21 * W1 - 20 * S ;$$

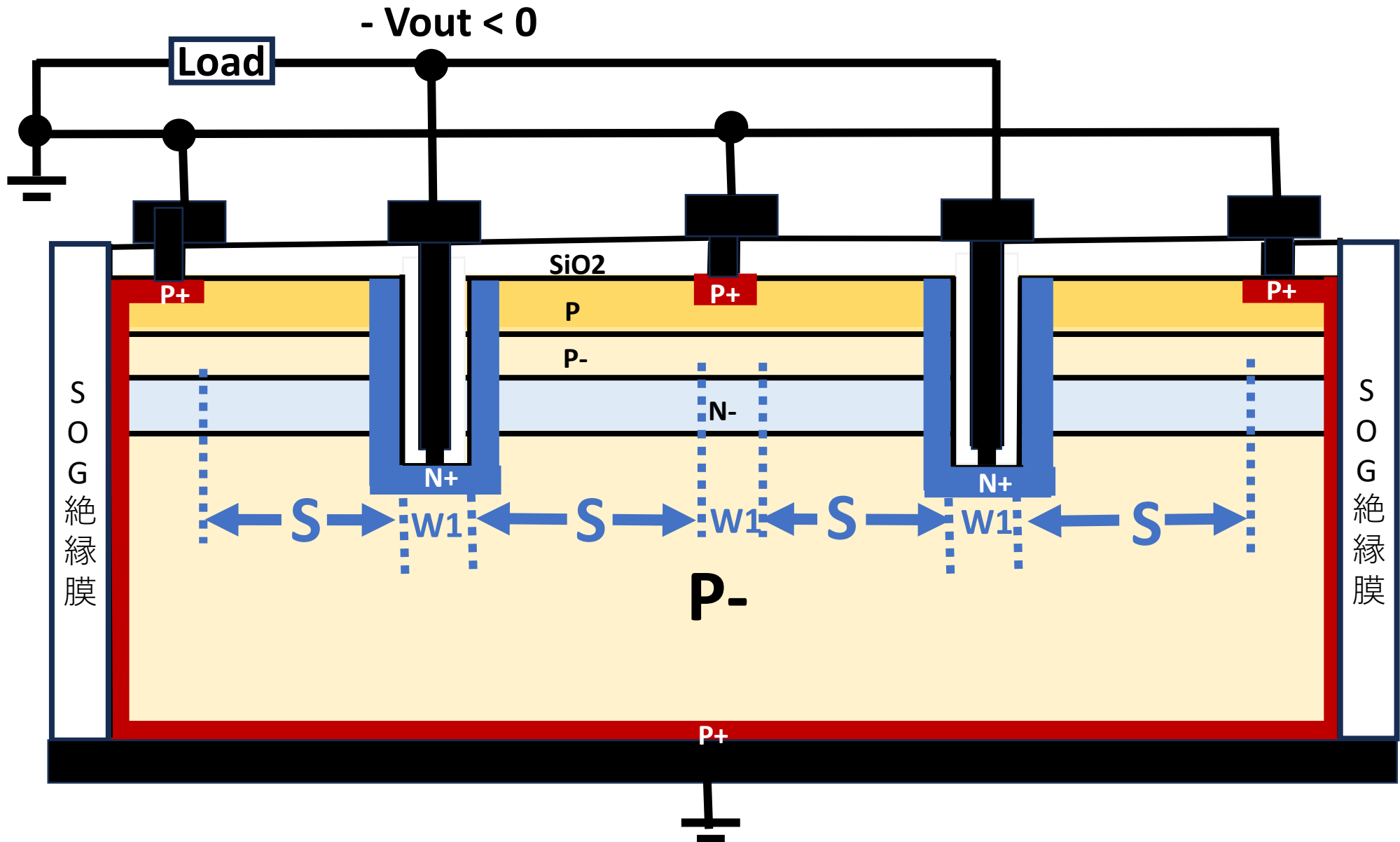
Choose S = 1.1 and W1 = 0.3.

We have (D + E) = 8 - 6.3 = 1.7

Choose D = 0.9 and E = 0.8.

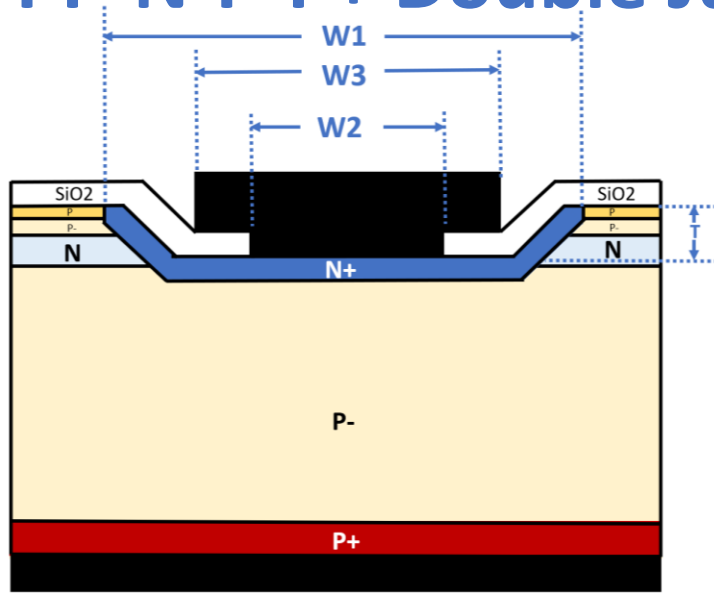
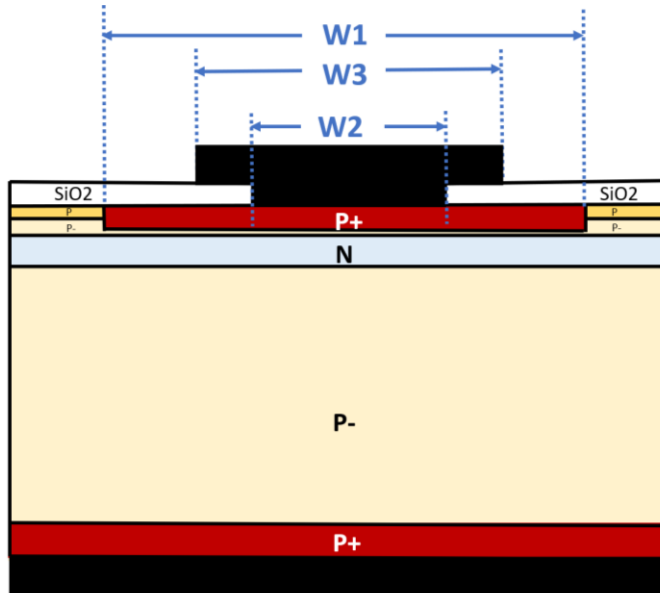
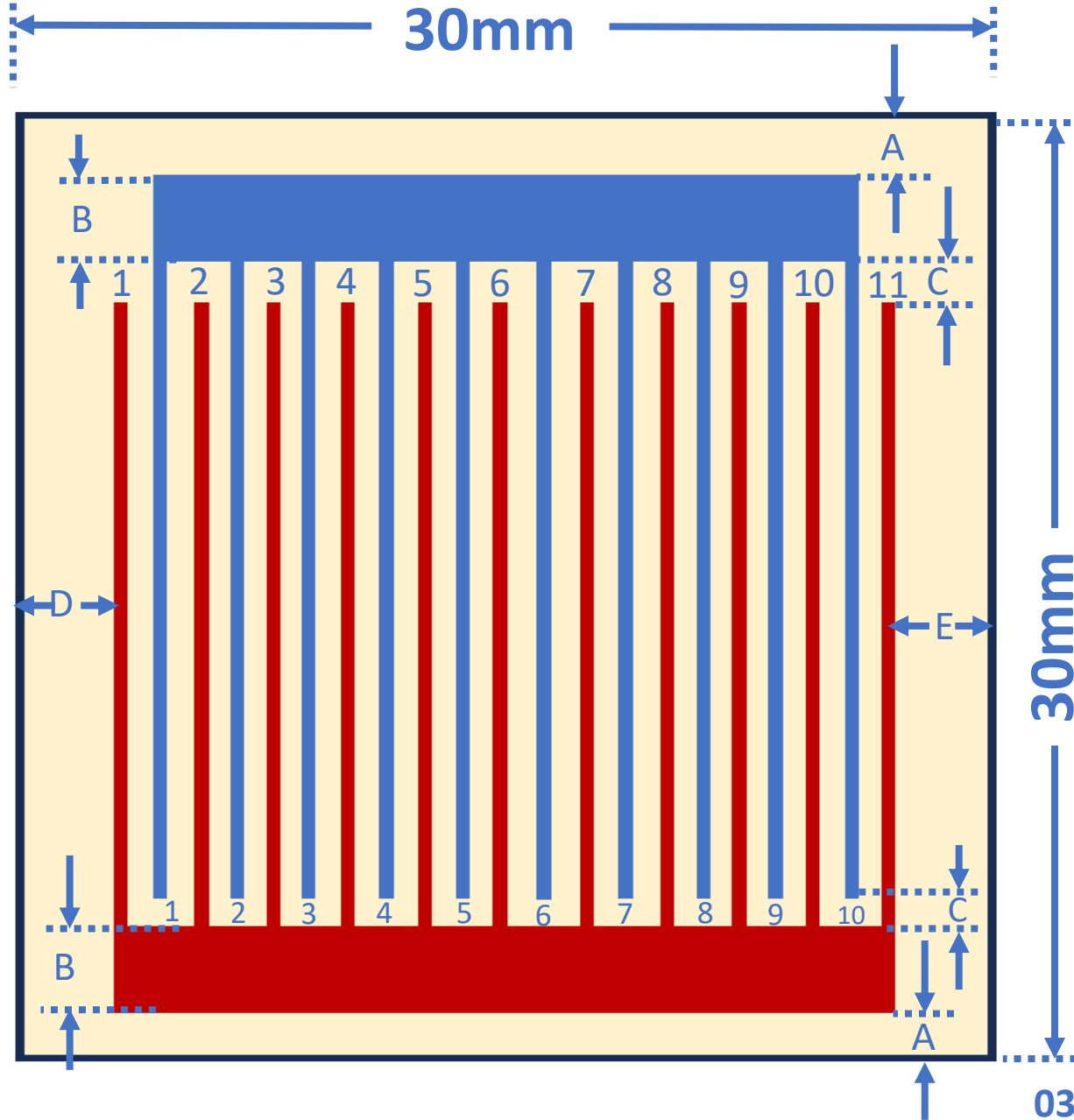
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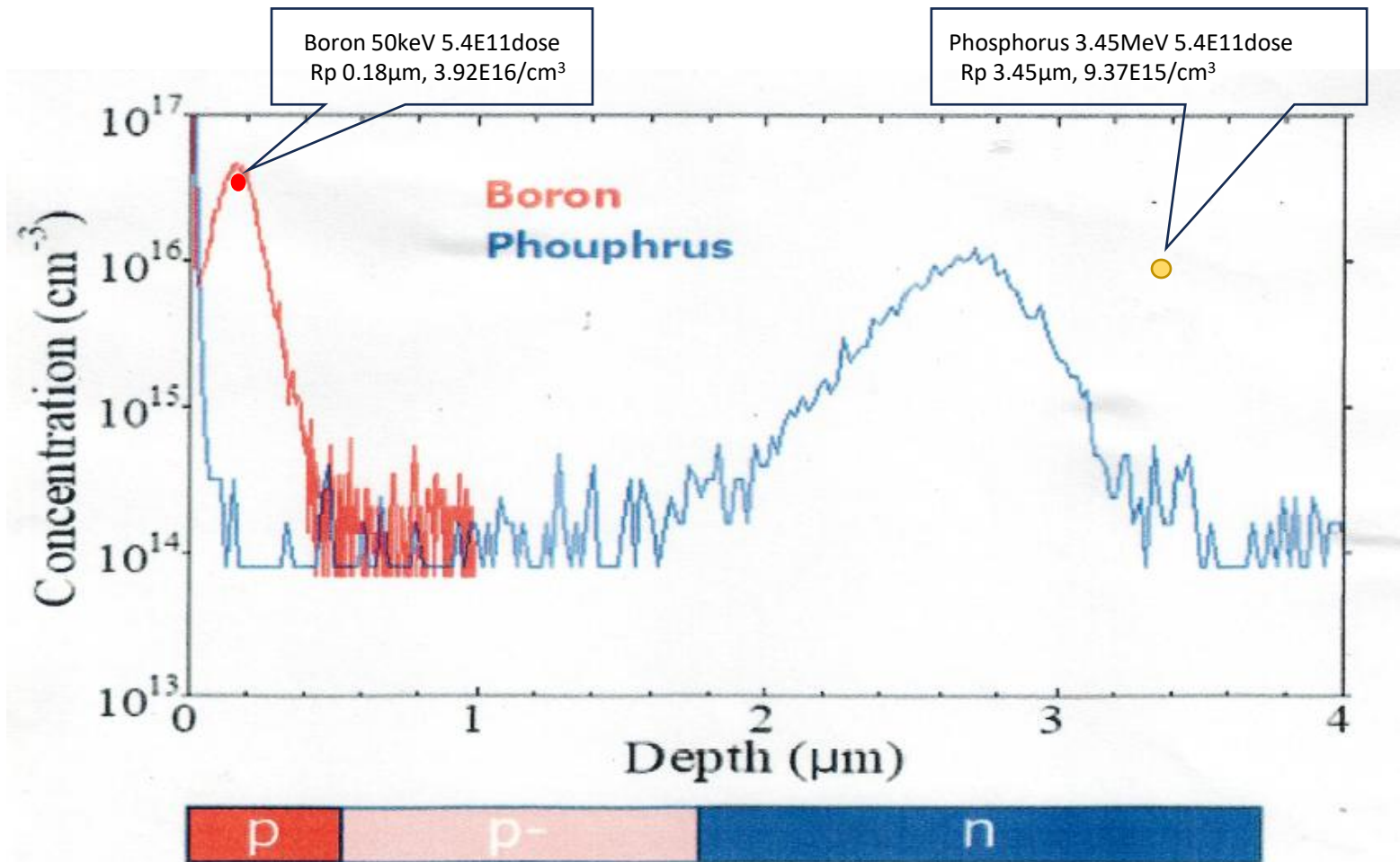


Fig.9 Impurity Doping Profile of Fabricated PP-NP- Junction Sample

P型100Ωcmシリコンウェハ キャリア濃度 $1.4 \times 10^{14} \text{cm}^{-3}$

熱処理を1050℃で1時間1回、2時間3回、合計7時間行った場合の、各々ボロンとリンのピーク濃度と深さを計算

ボロン

Dose (cm^{-2})	Peak Depth (μm)	ΔR_p (μm)	Peak Conc. (cm^{-3})
1.8E10	0.18	0.636	1.13E14
5.4E10	0.18	0.636	3.39E14
1.8E11	0.18	0.636	1.13E15
5.4E11	0.18	0.636	3.39E15

採用値



KOHシリコン Eching の深さは $d = 4\mu\text{m}$ が必要です。

リン

Dose (cm^{-2})	Peak Depth (μm)	ΔR_p (μm)	Peak Conc. (cm^{-3})
1.8E10	3.45	0.683	1.05E14
5.4E10	3.45	0.683	3.16E14
1.8E11	3.45	0.683	1.05E15
5.4E11	3.45	0.683	3.16E15

採用値



P型100Ωcmシリコンウェハ キャリア濃度 $1.4 \times 10^{14} \text{cm}^{-3}$

熱処理を1050℃で1時間4回、合計4時間行った場合の、各々ボロンとリンのピーク濃度と深さを計算

ボロン

Dose (cm^{-2})	Peak Depth Rp (μm)	ΔRp (μm)	Peak Concentration (cm^{-3})
1.8×10^{10}	0.18	0.521	1.38×10^{14}
5.4×10^{10}	0.18	0.521	4.14×10^{14}
1.8×10^{11}	0.18	0.521	1.38×10^{15}
5.4×10^{11}	0.18	0.521	4.14×10^{15}

採用値



KOHシリコン Eching の深さは $d = 4\mu\text{m}$ が必要です。

リン

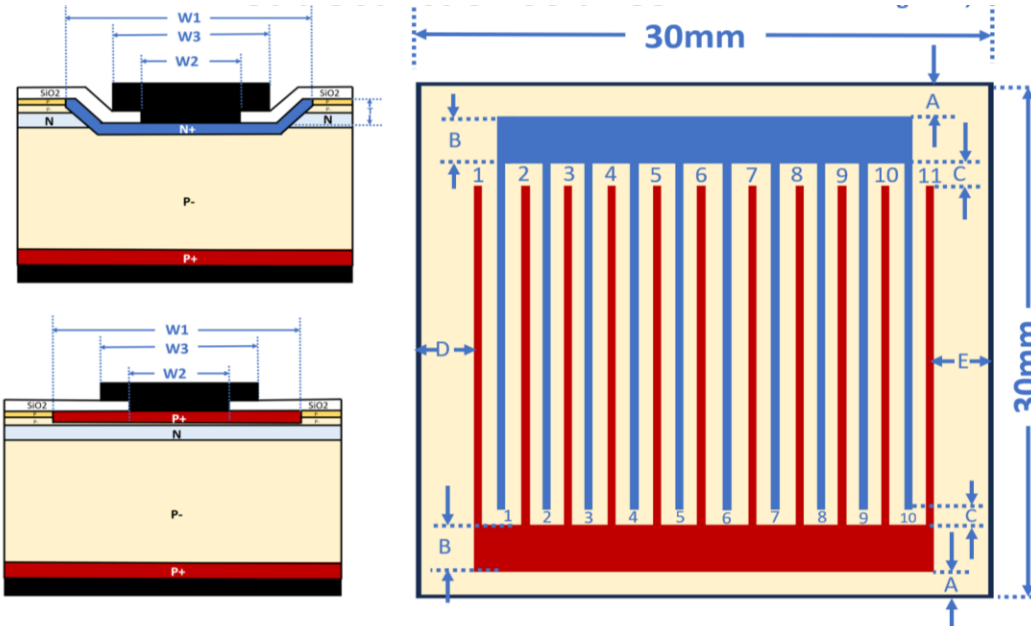
Dose (cm^{-2})	Peak Depth Rp (μm)	ΔRp (μm)	Peak Concentration (cm^{-3})
1.8×10^{10}	3.45	0.567	1.27×10^{14}
5.4×10^{10}	3.45	0.567	3.80×10^{14}
1.8×10^{11}	3.45	0.567	1.27×10^{15}
5.4×10^{11}	3.45	0.567	3.80×10^{15}

採用値



PP-N-P-P+ Double Junction Solar Cell

Yoshiaki Hagiwara, AIPS



MASK01 Silicon KOH Etching and N+ Diffusion

MASK02 P+ Diffusion

MASK03 Contact Window

MASK04 Metal Wiring

Line Length (L) :

$$30 = 2 (A + B) - C + L ;$$

$$L = 30 - 2 (A + B) - C ;$$

Choose A=B=C=1.

We have L = 25.

Line Spacing (S) :

$$30 = D + E + 21 * W1 + 20 * S ;$$

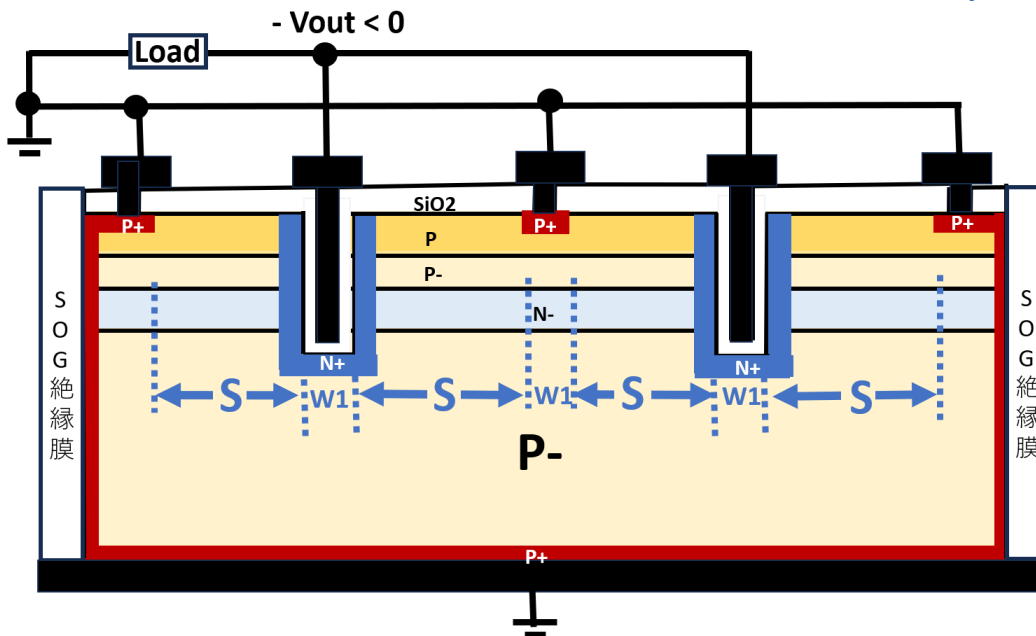
$$S = (30 - D - E - 21 * W1) / 20 ;$$

$$D + E = 30 - 21 * W1 - 20 * S ;$$

Choose S = 1.1 and W1 = 0.3.

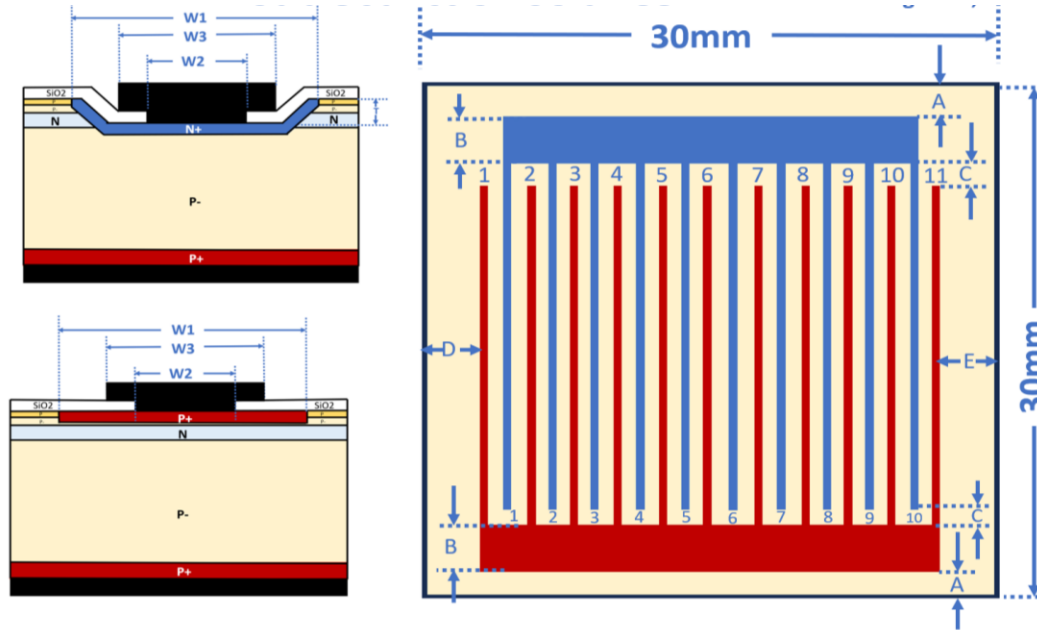
We have (D + E) = 8 - 6.3 = 1.7

Choose D= 0.9 and E = 0.8.



PP-N-P-P+ Double Junction Solar Cell

Yoshiaki Hagiwara, AIPS

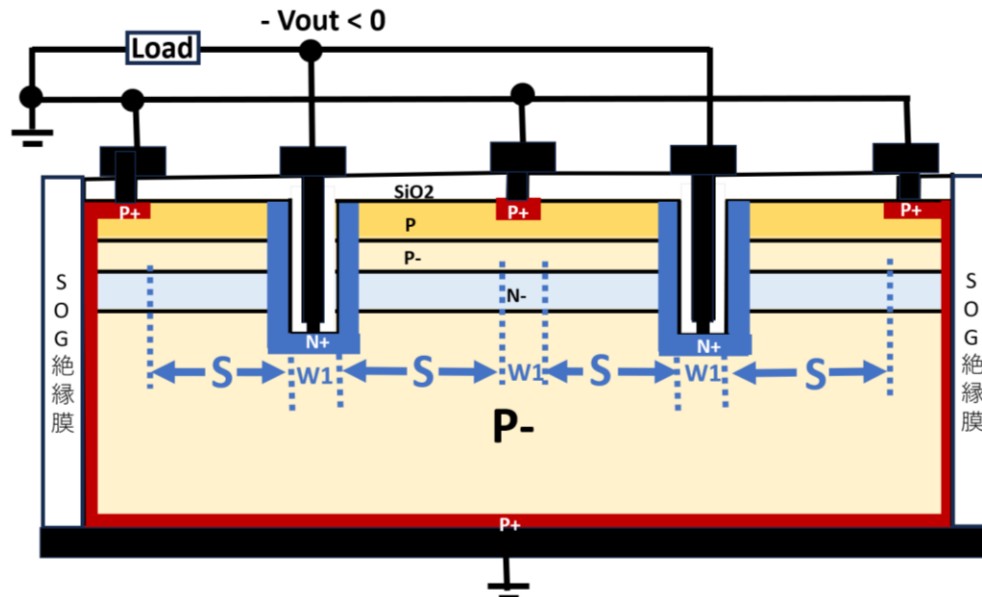


$A=1; B=1; C=1; D=0.9; E=0.8; L=25;$
 $W1=0.3; W2=0.1; W3=0.2; S=1.1;$

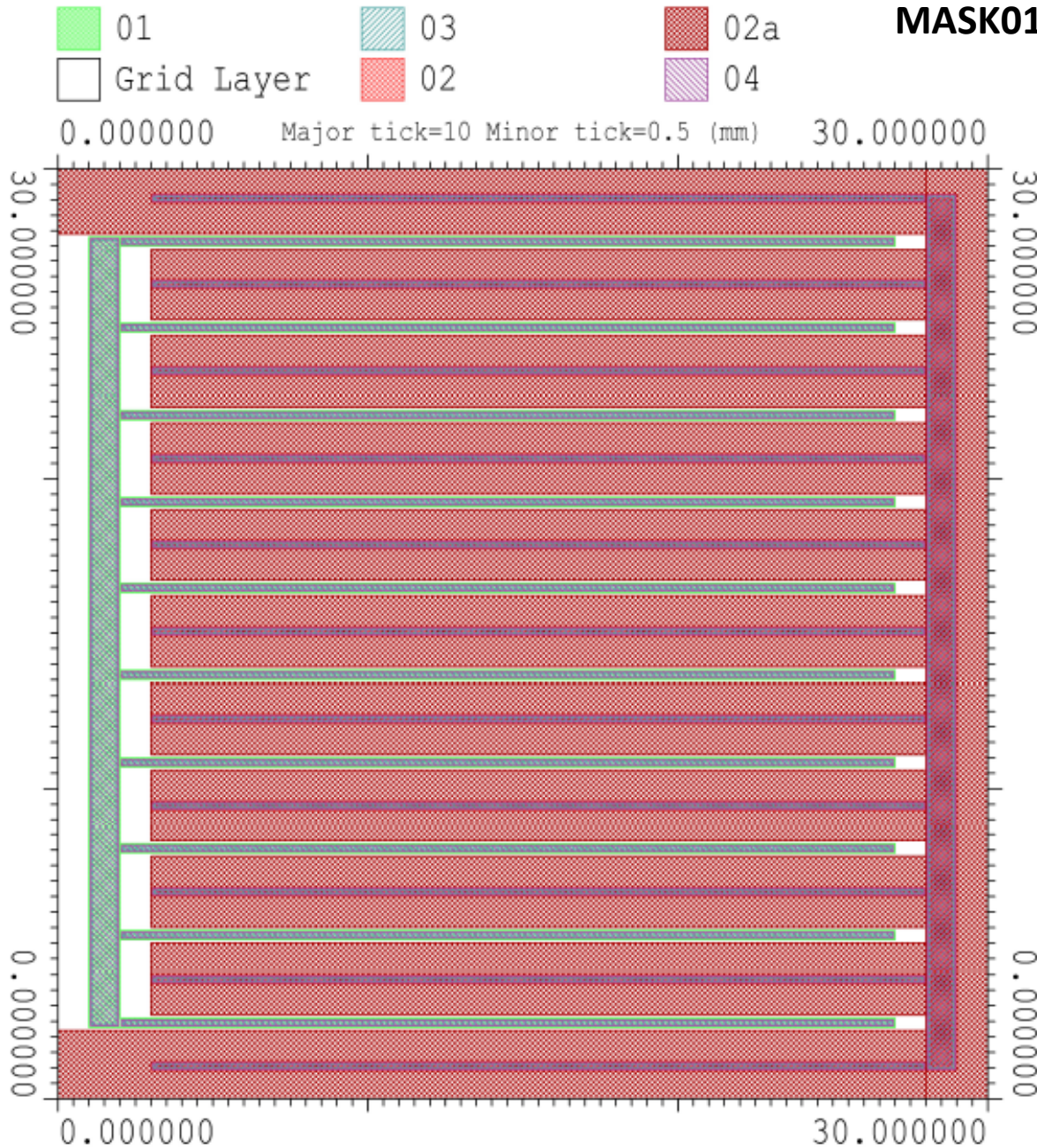
MASK01 Silicon KOH Etching and N+ Diffusion

***** MASK1 *****

1000	X= 1.0	Y= 2.3	W= 1.0	H= 25.5
1001	X= 2.0	Y= 2.3	W= 25.0	H= 0.3
1002	X= 2.0	Y= 5.1	W= 25.0	H= 0.3
1003	X= 2.0	Y= 7.9	W= 25.0	H= 0.3
1004	X= 2.0	Y= 10.7	W= 25.0	H= 0.3
1005	X= 2.0	Y= 13.5	W= 25.0	H= 0.3
1006	X= 2.0	Y= 16.3	W= 25.0	H= 0.3
1007	X= 2.0	Y= 19.1	W= 25.0	H= 0.3
1008	X= 2.0	Y= 21.9	W= 25.0	H= 0.3
1009	X= 2.0	Y= 24.7	W= 25.0	H= 0.3
1010	X= 2.0	Y= 27.5	W= 25.0	H= 0.3

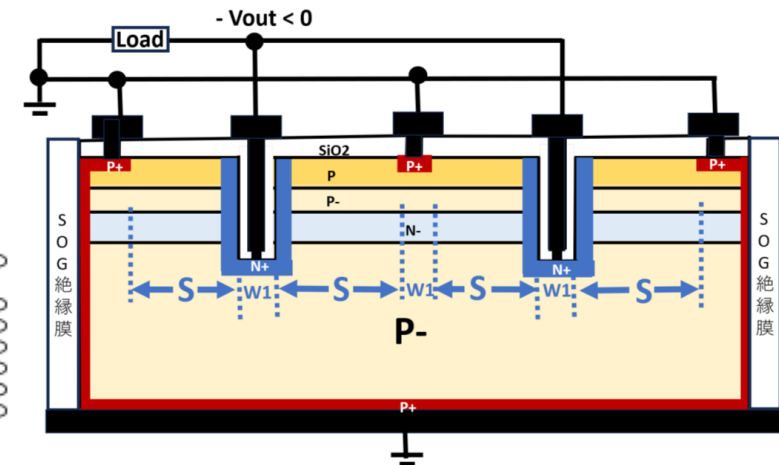


MASK01 Silicon KOH Etching and N+ Diffusion



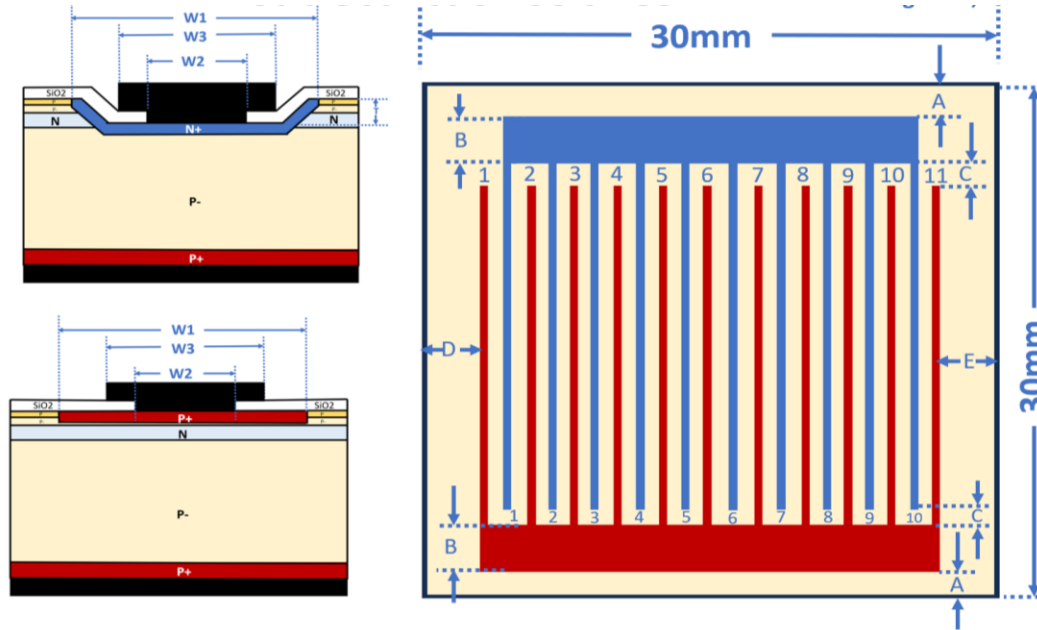
***** MASK1 *****

1000	X= 1.0	Y= 2.3	W= 1.0	H= 25.5
1001	X= 2.0	Y= 2.3	W= 25.0	H= 0.3
1002	X= 2.0	Y= 5.1	W= 25.0	H= 0.3
1003	X= 2.0	Y= 7.9	W= 25.0	H= 0.3
1004	X= 2.0	Y= 10.7	W= 25.0	H= 0.3
1005	X= 2.0	Y= 13.5	W= 25.0	H= 0.3
1006	X= 2.0	Y= 16.3	W= 25.0	H= 0.3
1007	X= 2.0	Y= 19.1	W= 25.0	H= 0.3
1008	X= 2.0	Y= 21.9	W= 25.0	H= 0.3
1009	X= 2.0	Y= 24.7	W= 25.0	H= 0.3
1010	X= 2.0	Y= 27.5	W= 25.0	H= 0.3



PP-N-P-P+ Double Junction Solar Cell

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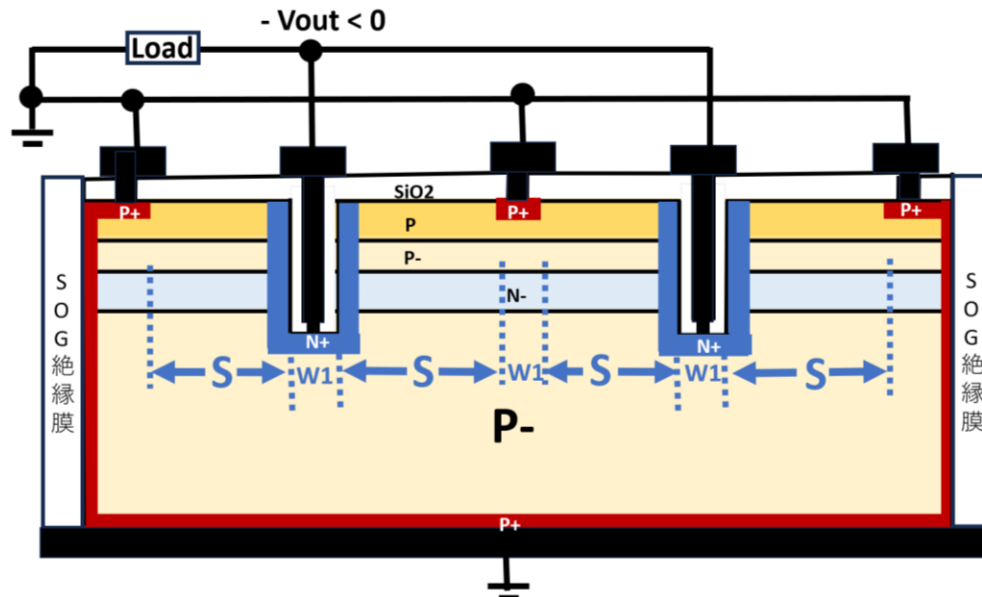


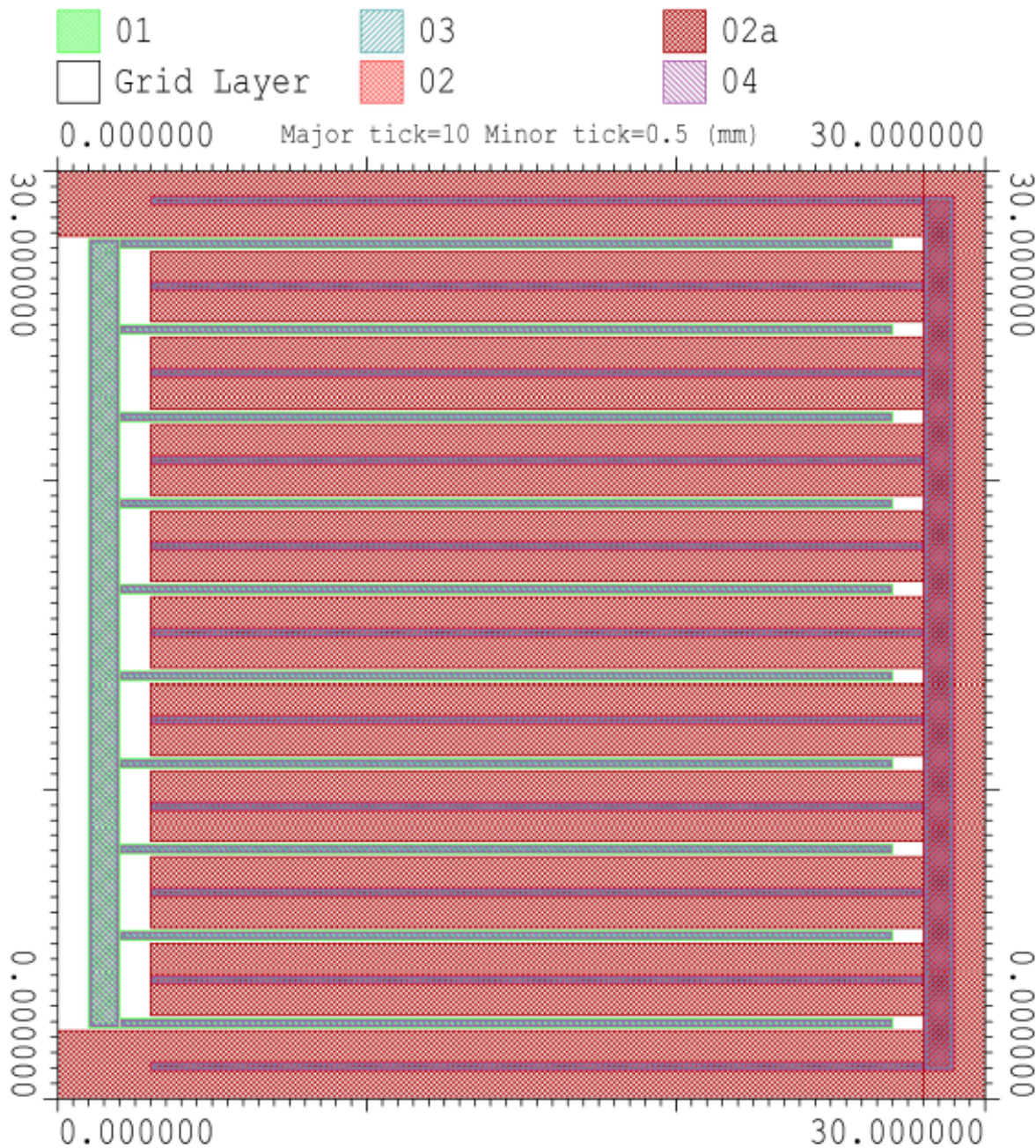
$A=1; B=1; C=1; D=0.9; E=0.8; L=25;$
 $W1=0.3; W2=0.1; W3=0.2; S=1.1;$

MASK02 P+ Diffusion

***** MASK2 *****

2000	X= 28.0	Y= 0.9	W= 1.0	H= 28.3
2001	X= 3.0	Y= 0.9	W= 25.0	H= 0.3
2002	X= 3.0	Y= 3.7	W= 25.0	H= 0.3
2003	X= 3.0	Y= 6.5	W= 25.0	H= 0.3
2004	X= 3.0	Y= 9.3	W= 25.0	H= 0.3
2005	X= 3.0	Y= 12.1	W= 25.0	H= 0.3
2006	X= 3.0	Y= 14.9	W= 25.0	H= 0.3
2007	X= 3.0	Y= 17.7	W= 25.0	H= 0.3
2008	X= 3.0	Y= 20.5	W= 25.0	H= 0.3
2009	X= 3.0	Y= 23.3	W= 25.0	H= 0.3
2010	X= 3.0	Y= 26.1	W= 25.0	H= 0.3
2011	X= 3.0	Y= 28.9	W= 25.0	H= 0.3

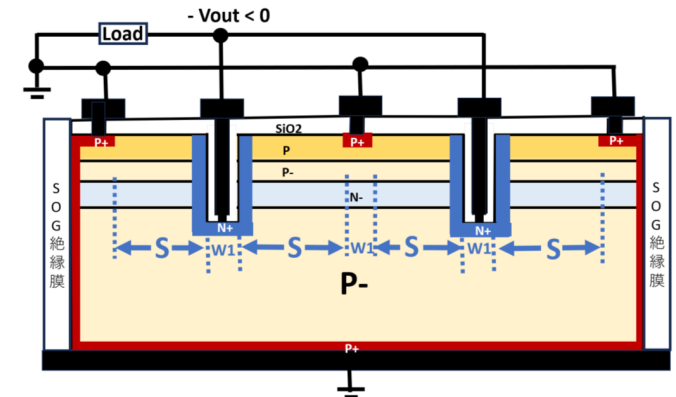




MASK02 P+ Diffusion

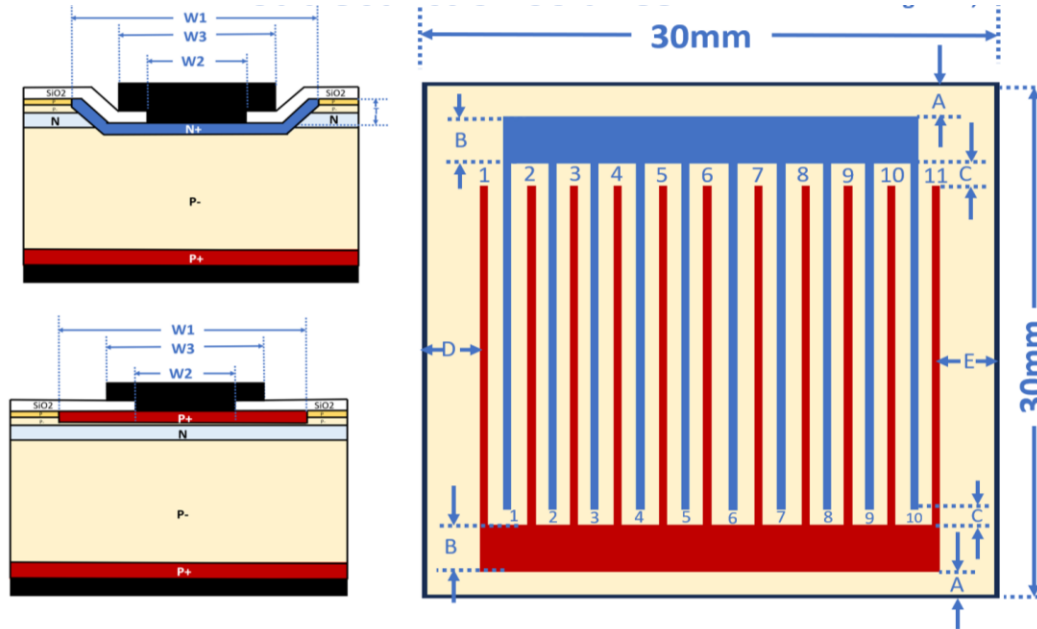
***** MASK2 *****

2000	X= 28.0	Y= 0.9	W= 1.0	H= 28.3
2001	X= 3.0	Y= 0.9	W= 25.0	H= 0.3
2002	X= 3.0	Y= 3.7	W= 25.0	H= 0.3
2003	X= 3.0	Y= 6.5	W= 25.0	H= 0.3
2004	X= 3.0	Y= 9.3	W= 25.0	H= 0.3
2005	X= 3.0	Y= 12.1	W= 25.0	H= 0.3
2006	X= 3.0	Y= 14.9	W= 25.0	H= 0.3
2007	X= 3.0	Y= 17.7	W= 25.0	H= 0.3
2008	X= 3.0	Y= 20.5	W= 25.0	H= 0.3
2009	X= 3.0	Y= 23.3	W= 25.0	H= 0.3
2010	X= 3.0	Y= 26.1	W= 25.0	H= 0.3
2011	X= 3.0	Y= 28.9	W= 25.0	H= 0.3



PP-N-P-P+ Double Junction Solar Cell

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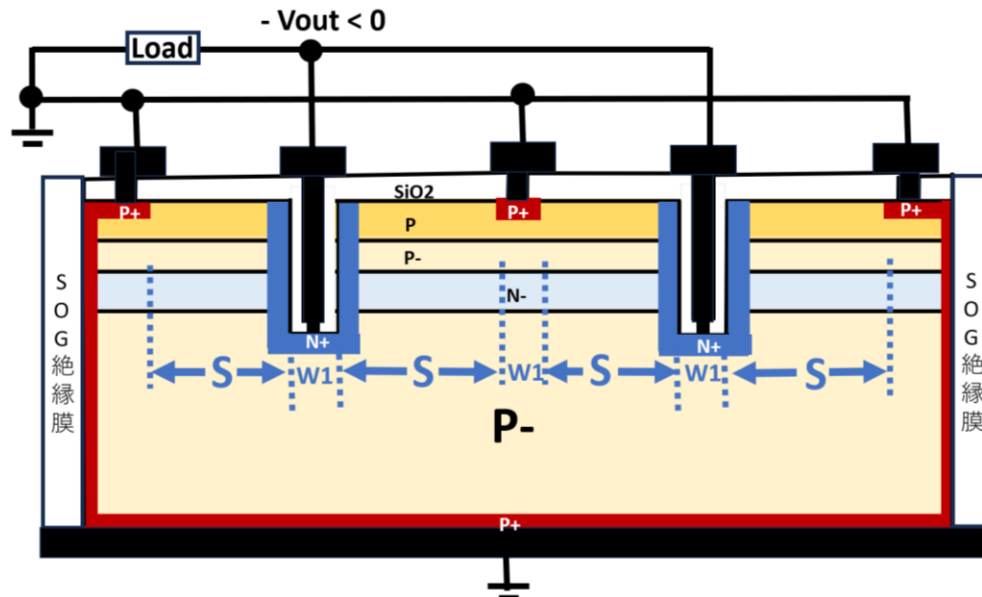


$A=1; B=1; C=1; D=0.9; E=0.8; L=25;$
 $W1=0.3; W2=0.1; W3=0.2; S=1.1;$

MASK02A P+ Diffusion

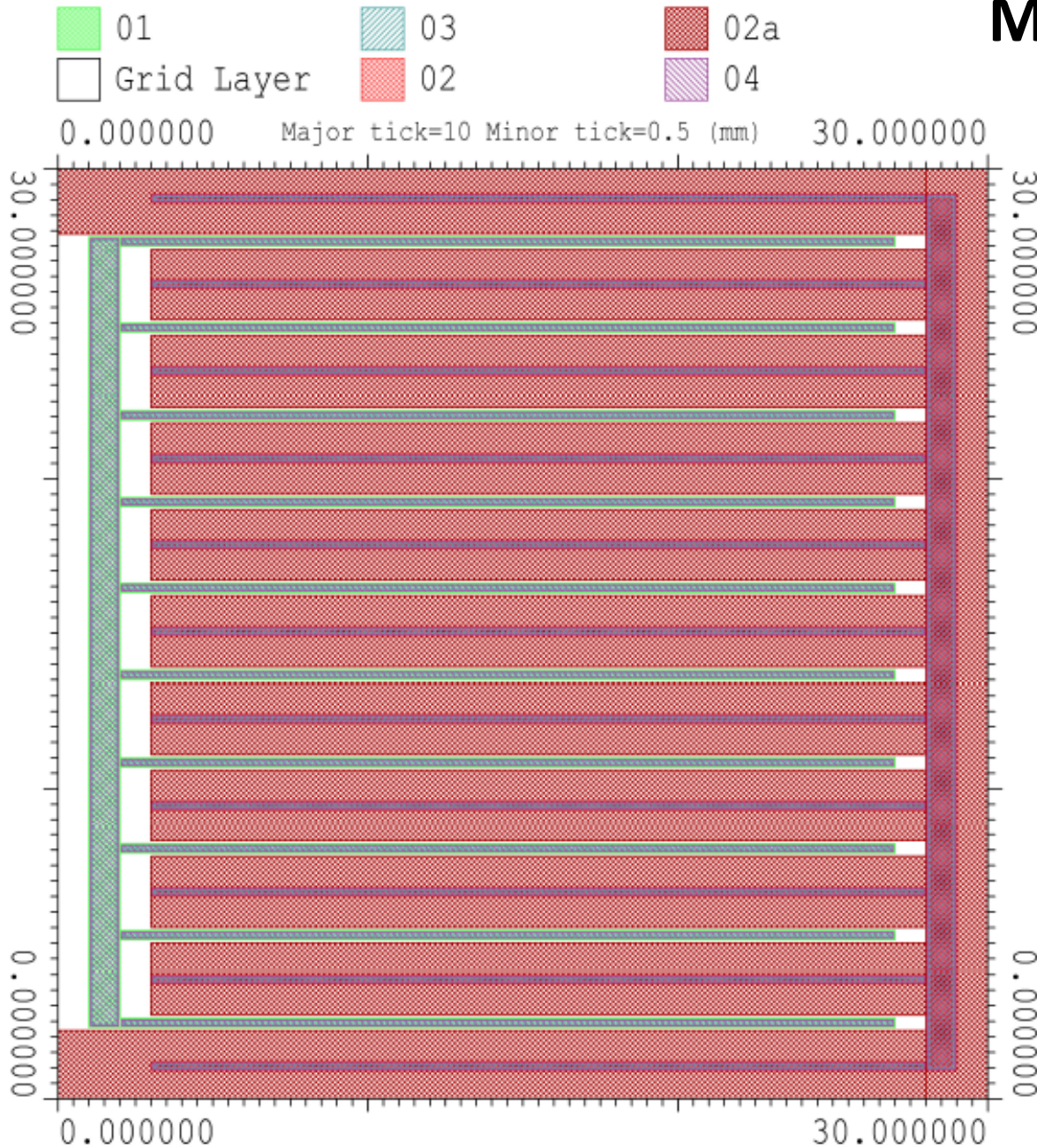
***** MASK2A *****

5000	X= 28.0	Y= 0.0	W= 2.0	H= 30.0
5001	X= 0.0	Y= 0.0	W= 28.0	H= 2.2
5002	X= 3.0	Y= 2.7	W= 25.0	H= 2.3
5003	X= 3.0	Y= 5.5	W= 25.0	H= 2.3
5004	X= 3.0	Y= 8.3	W= 25.0	H= 2.3
5005	X= 3.0	Y= 11.1	W= 25.0	H= 2.3
5006	X= 3.0	Y= 13.9	W= 25.0	H= 2.3
5007	X= 3.0	Y= 16.7	W= 25.0	H= 2.3
5008	X= 3.0	Y= 19.5	W= 25.0	H= 2.3
5009	X= 3.0	Y= 22.3	W= 25.0	H= 2.3
5010	X= 3.0	Y= 25.1	W= 25.0	H= 2.3
5011	X= 0.0	Y= 27.9	W= 28.0	H= 2.1



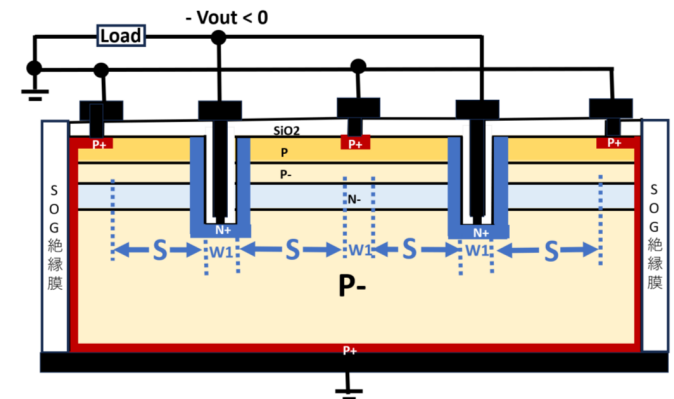
Option 2: Use MASK02A instead of MASK02.
 And for P+ diffusion, we have $W1= 2.1$
 instead of $W1=0.3$;

MASK02A P+ Diffusion



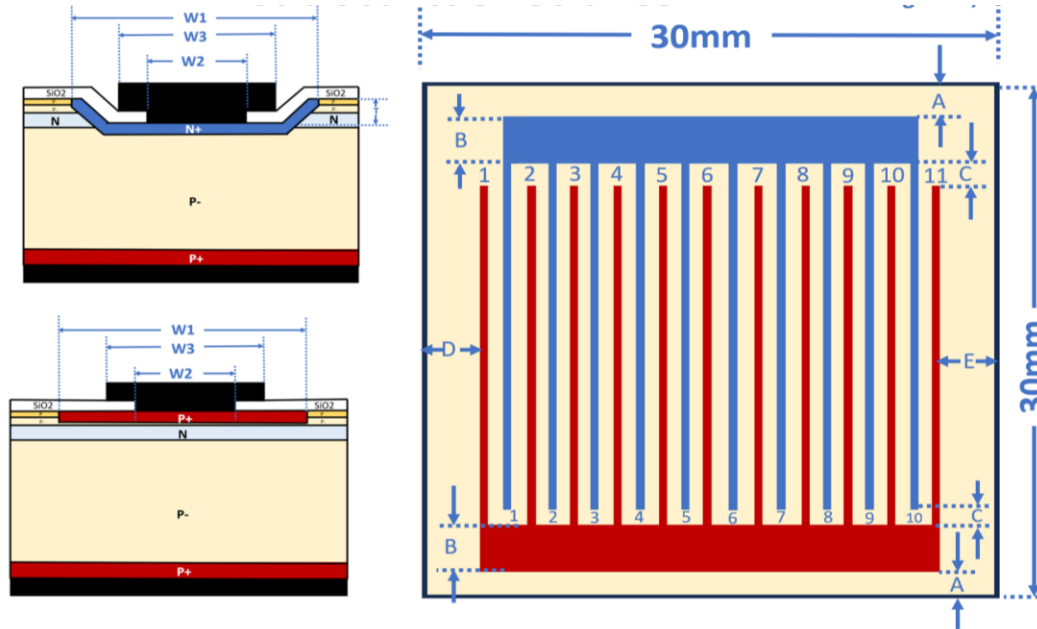
***** MASK2A *****

5000	X= 28.0	Y= 0.0	W= 2.0	H= 30.0
5001	X= 0.0	Y= 0.0	W= 28.0	H= 2.2
5002	X= 3.0	Y= 2.7	W= 25.0	H= 2.3
5003	X= 3.0	Y= 5.5	W= 25.0	H= 2.3
5004	X= 3.0	Y= 8.3	W= 25.0	H= 2.3
5005	X= 3.0	Y= 11.1	W= 25.0	H= 2.3
5006	X= 3.0	Y= 13.9	W= 25.0	H= 2.3
5007	X= 3.0	Y= 16.7	W= 25.0	H= 2.3
5008	X= 3.0	Y= 19.5	W= 25.0	H= 2.3
5009	X= 3.0	Y= 22.3	W= 25.0	H= 2.3
5010	X= 3.0	Y= 25.1	W= 25.0	H= 2.3
5011	X= 0.0	Y= 27.9	W= 28.0	H= 2.1



PP-N-P-P+ Double Junction Solar Cell

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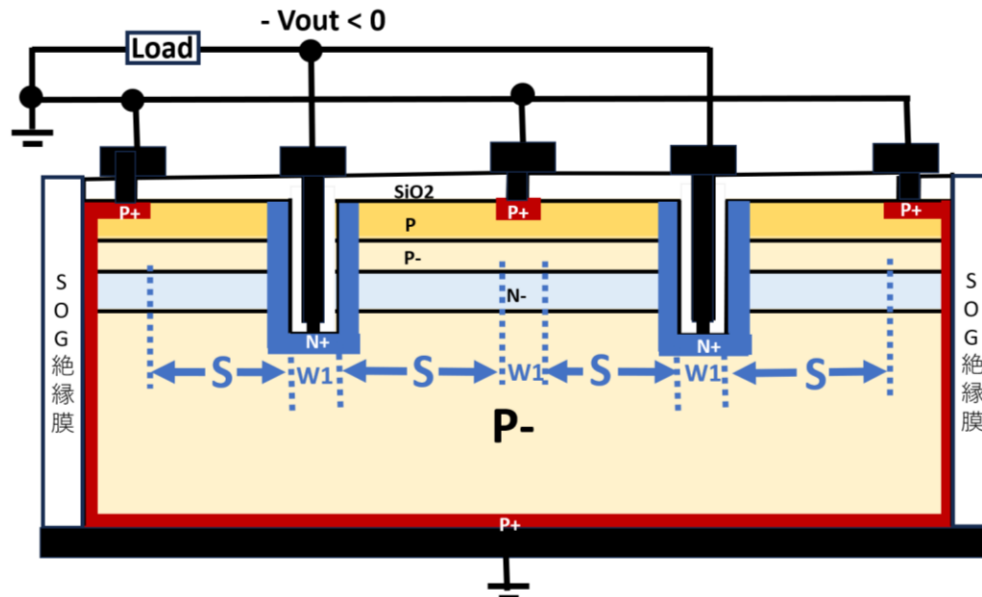


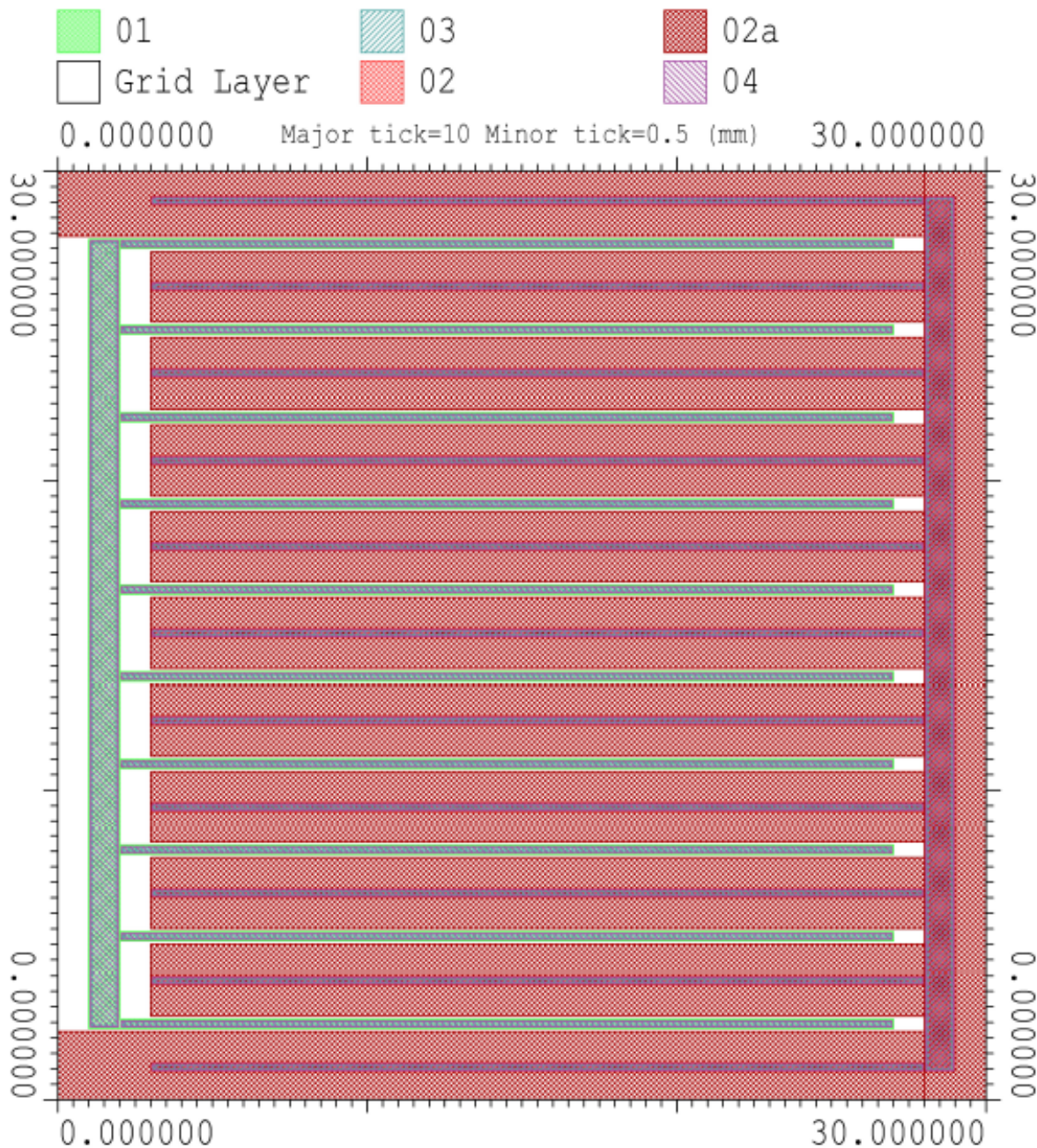
$A=1; B=1; C=1; D=0.9; E=0.8; L=25;$
 $W1=0.3; W2=0.1; W3=0.2; S=1.1;$

MASK03 Contact Window

***** MASK3 *****

3000	X=1.100000	Y=2.400000	W=0.800000	H=25.300000
3001	X=1.900000	Y=2.400000	W=25.000000	H=0.100000
3002	X=1.900000	Y=5.200000	W=25.000000	H=0.100000
3003	X=1.900000	Y=8.000000	W=25.000000	H=0.100000
3004	X=1.900000	Y=10.800000	W=25.000000	H=0.100000
3005	X=1.900000	Y=13.600000	W=25.000000	H=0.100000
3006	X=1.900000	Y=16.400000	W=25.000000	H=0.100000
3007	X=1.900000	Y=19.200000	W=25.000000	H=0.100000
3008	X=1.900000	Y=22.000000	W=25.000000	H=0.100000
3009	X=1.900000	Y=24.800000	W=25.000000	H=0.100000
3010	X=1.900000	Y=27.600000	W=25.000000	H=0.100000
3100	X=28.100000	Y=1.000000	W=1.000000	H=28.100000
3101	X=3.100000	Y=1.000000	W=25.000000	H=0.100000
3102	X=3.100000	Y=3.800000	W=25.000000	H=0.100000
3103	X=3.100000	Y=6.600000	W=25.000000	H=0.100000
3104	X=3.100000	Y=9.400000	W=25.000000	H=0.100000
3105	X=3.100000	Y=12.200000	W=25.000000	H=0.100000
3106	X=3.100000	Y=15.000000	W=25.000000	H=0.100000
3107	X=3.100000	Y=17.800000	W=25.000000	H=0.100000
3108	X=3.100000	Y=20.600000	W=25.000000	H=0.100000
3109	X=3.100000	Y=23.400000	W=25.000000	H=0.100000
3110	X=3.100000	Y=26.200000	W=25.000000	H=0.100000
3111	X=3.100000	Y=29.000000	W=25.000000	H=0.100000

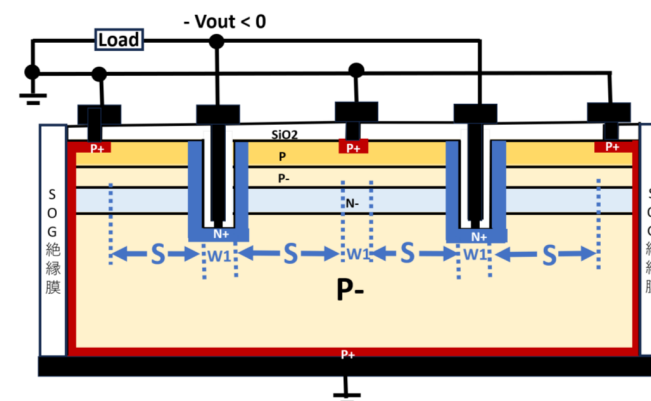




MASK03 Contact Window

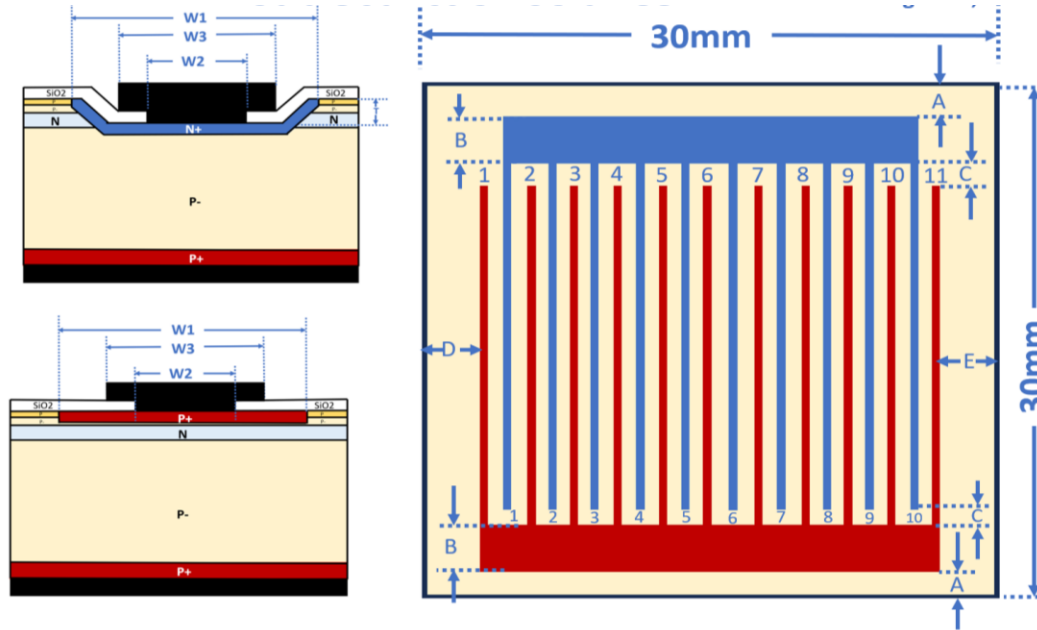
***** MASK3 *****

3000	X=1.100000	Y=2.400000	W=0.800000	H=25.300000
3001	X=1.900000	Y=2.400000	W=25.000000	H=0.100000
3002	X=1.900000	Y=5.200000	W=25.000000	H=0.100000
3003	X=1.900000	Y=8.000000	W=25.000000	H=0.100000
3004	X=1.900000	Y=10.800000	W=25.000000	H=0.100000
3005	X=1.900000	Y=13.600000	W=25.000000	H=0.100000
3006	X=1.900000	Y=16.400000	W=25.000000	H=0.100000
3007	X=1.900000	Y=19.200000	W=25.000000	H=0.100000
3008	X=1.900000	Y=22.000000	W=25.000000	H=0.100000
3009	X=1.900000	Y=24.800000	W=25.000000	H=0.100000
3010	X=1.900000	Y=27.600000	W=25.000000	H=0.100000
3100	X=28.100000	Y=1.000000	W=1.000000	H=28.100000
3101	X=3.100000	Y=1.000000	W=25.000000	H=0.100000
3102	X=3.100000	Y=3.800000	W=25.000000	H=0.100000
3103	X=3.100000	Y=6.600000	W=25.000000	H=0.100000
3104	X=3.100000	Y=9.400000	W=25.000000	H=0.100000
3105	X=3.100000	Y=12.200000	W=25.000000	H=0.100000
3106	X=3.100000	Y=15.000000	W=25.000000	H=0.100000
3107	X=3.100000	Y=17.800000	W=25.000000	H=0.100000
3108	X=3.100000	Y=20.600000	W=25.000000	H=0.100000
3109	X=3.100000	Y=23.400000	W=25.000000	H=0.100000
3110	X=3.100000	Y=26.200000	W=25.000000	H=0.100000
3111	X=3.100000	Y=29.000000	W=25.000000	H=0.100000



PP-N-P-P+ Double Junction Solar Cell

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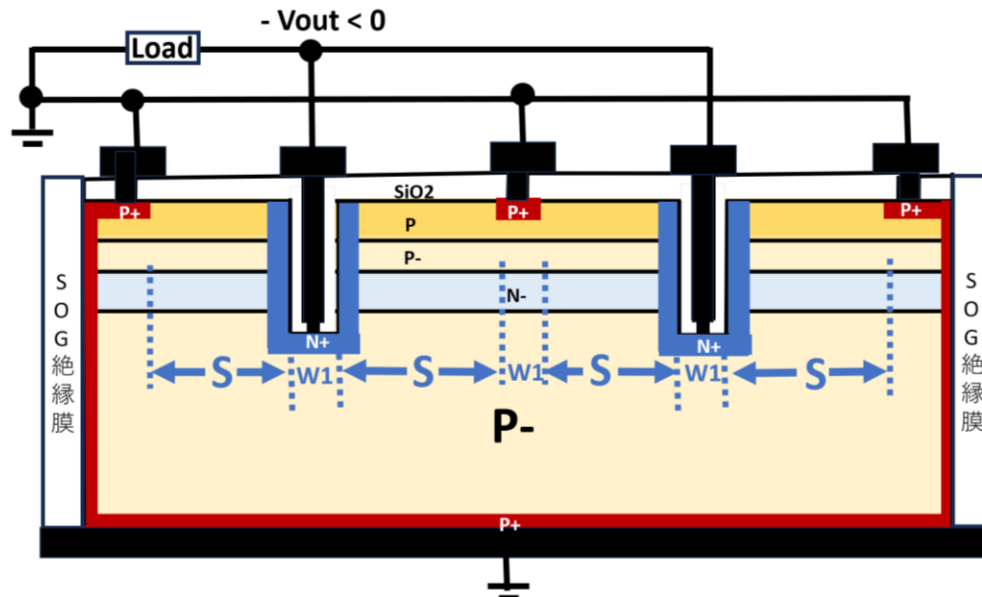


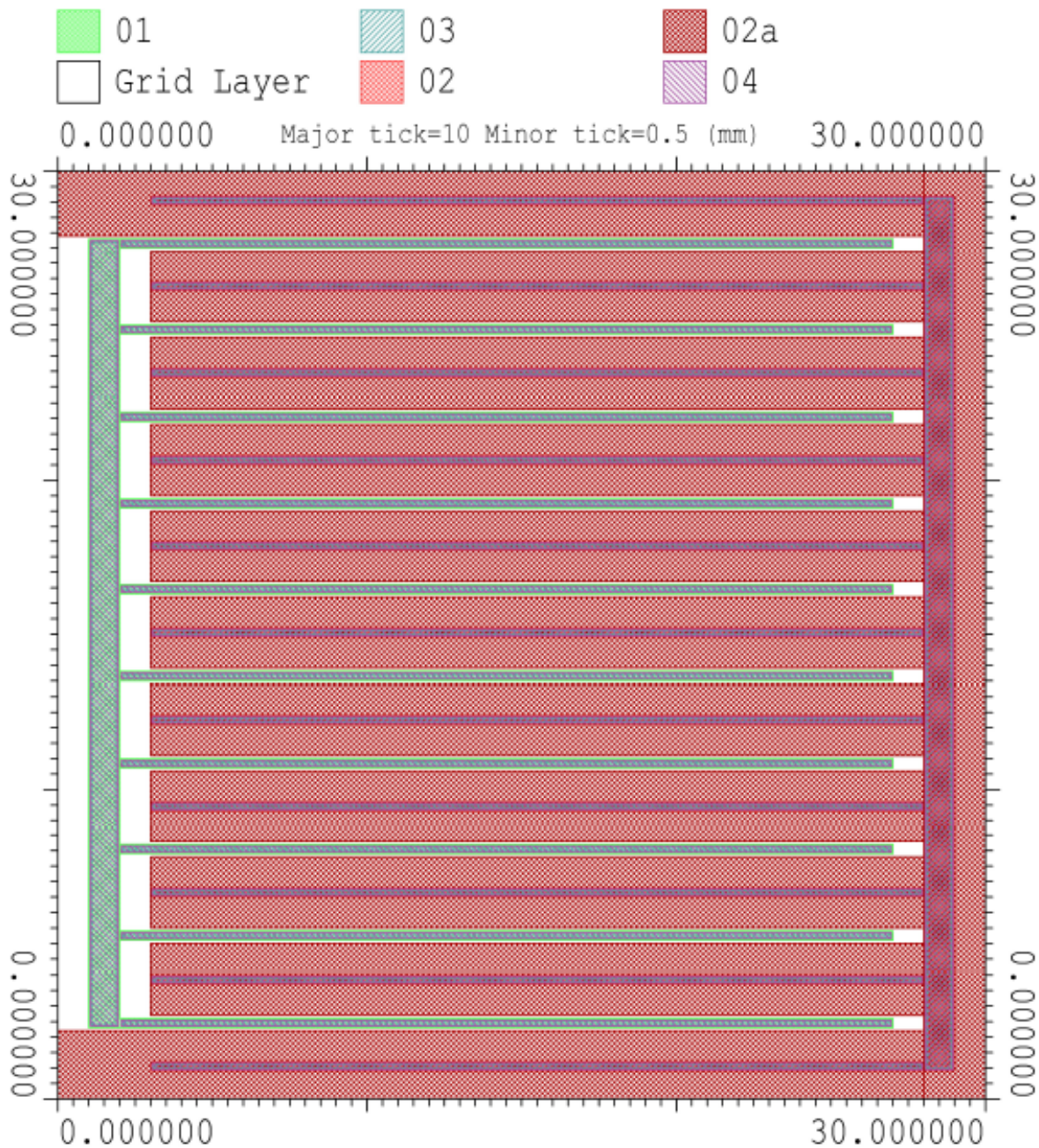
$A=1; B=1; C=1; D=0.9; E=0.8; L=25;$
 $W1=0.3; W2=0.1; W3=0.2; S=1.1;$

MASK04 Metal Wiring

***** MASK4 *****

4000	X=1.050000	Y=2.350000	W=0.900000	H=25.400000
4001	X=1.950000	Y=2.350000	W=25.000000	H=0.200000
4002	X=1.950000	Y=5.150000	W=25.000000	H=0.200000
4003	X=1.950000	Y=7.950000	W=25.000000	H=0.200000
4004	X=1.950000	Y=10.750000	W=25.000000	H=0.200000
4005	X=1.950000	Y=13.550000	W=25.000000	H=0.200000
4006	X=1.950000	Y=16.350000	W=25.000000	H=0.200000
4007	X=1.950000	Y=19.150000	W=25.000000	H=0.200000
4008	X=1.950000	Y=21.950000	W=25.000000	H=0.200000
4009	X=1.950000	Y=24.750000	W=25.000000	H=0.200000
4010	X=1.950000	Y=27.550000	W=25.000000	H=0.200000
4100	X=28.050000	Y=0.950000	W=0.900000	H=28.200000
4101	X=3.050000	Y=0.950000	W=25.000000	H=0.200000
4102	X=3.050000	Y=3.750000	W=25.000000	H=0.200000
4103	X=3.050000	Y=6.550000	W=25.000000	H=0.200000
4104	X=3.050000	Y=9.350000	W=25.000000	H=0.200000
4105	X=3.050000	Y=12.150000	W=25.000000	H=0.200000
4106	X=3.050000	Y=14.950000	W=25.000000	H=0.200000
4107	X=3.050000	Y=17.750000	W=25.000000	H=0.200000
4108	X=3.050000	Y=20.550000	W=25.000000	H=0.200000
4109	X=3.050000	Y=23.350000	W=25.000000	H=0.200000
4110	X=3.050000	Y=26.150000	W=25.000000	H=0.200000
4111	X=3.050000	Y=28.950000	W=25.000000	H=0.200000

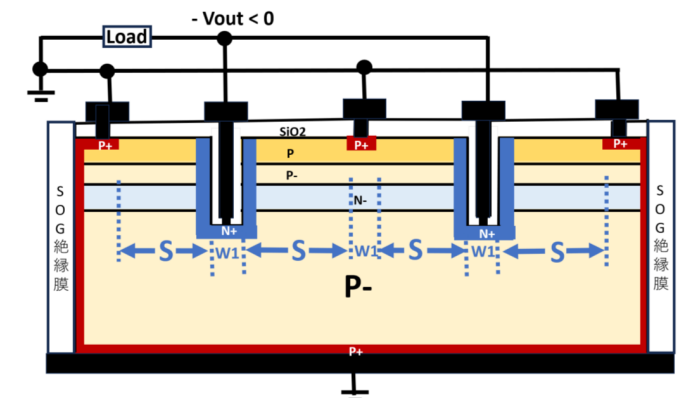




MASK04 Metal Wiring

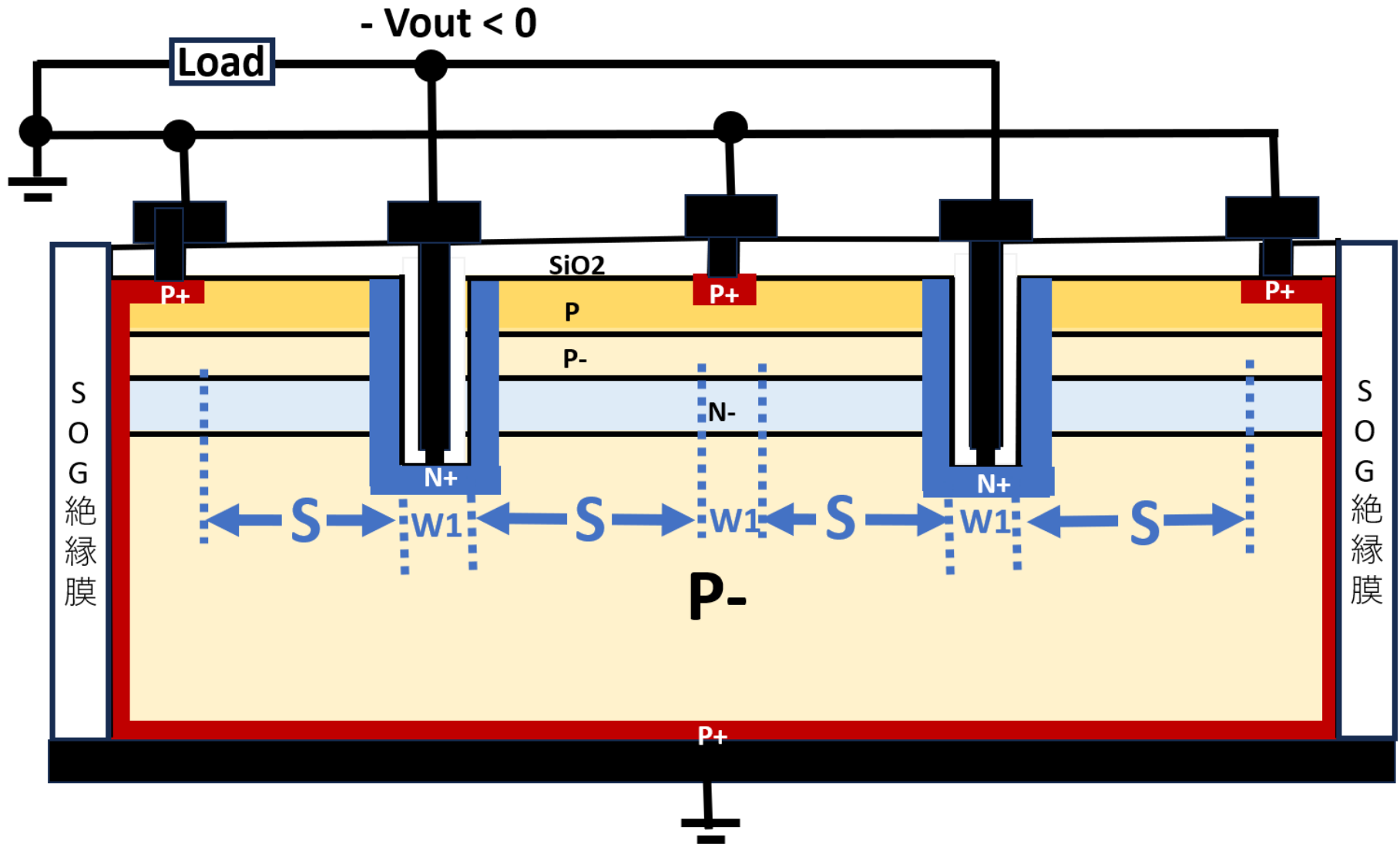
***** MASK4 *****

4000	X=1.050000	Y=2.350000	W=0.900000	H=25.400000
4001	X=1.950000	Y=2.350000	W=25.000000	H=0.200000
4002	X=1.950000	Y=5.150000	W=25.000000	H=0.200000
4003	X=1.950000	Y=7.950000	W=25.000000	H=0.200000
4004	X=1.950000	Y=10.750000	W=25.000000	H=0.200000
4005	X=1.950000	Y=13.550000	W=25.000000	H=0.200000
4006	X=1.950000	Y=16.350000	W=25.000000	H=0.200000
4007	X=1.950000	Y=19.150000	W=25.000000	H=0.200000
4008	X=1.950000	Y=21.950000	W=25.000000	H=0.200000
4009	X=1.950000	Y=24.750000	W=25.000000	H=0.200000
4010	X=1.950000	Y=27.550000	W=25.000000	H=0.200000
4100	X=28.050000	Y=0.950000	W=0.900000	H=28.200000
4101	X=3.050000	Y=0.950000	W=25.000000	H=0.200000
4102	X=3.050000	Y=3.750000	W=25.000000	H=0.200000
4103	X=3.050000	Y=6.550000	W=25.000000	H=0.200000
4104	X=3.050000	Y=9.350000	W=25.000000	H=0.200000
4105	X=3.050000	Y=12.150000	W=25.000000	H=0.200000
4106	X=3.050000	Y=14.950000	W=25.000000	H=0.200000
4107	X=3.050000	Y=17.750000	W=25.000000	H=0.200000
4108	X=3.050000	Y=20.550000	W=25.000000	H=0.200000
4109	X=3.050000	Y=23.350000	W=25.000000	H=0.200000
4110	X=3.050000	Y=26.150000	W=25.000000	H=0.200000
4111	X=3.050000	Y=28.950000	W=25.000000	H=0.200000

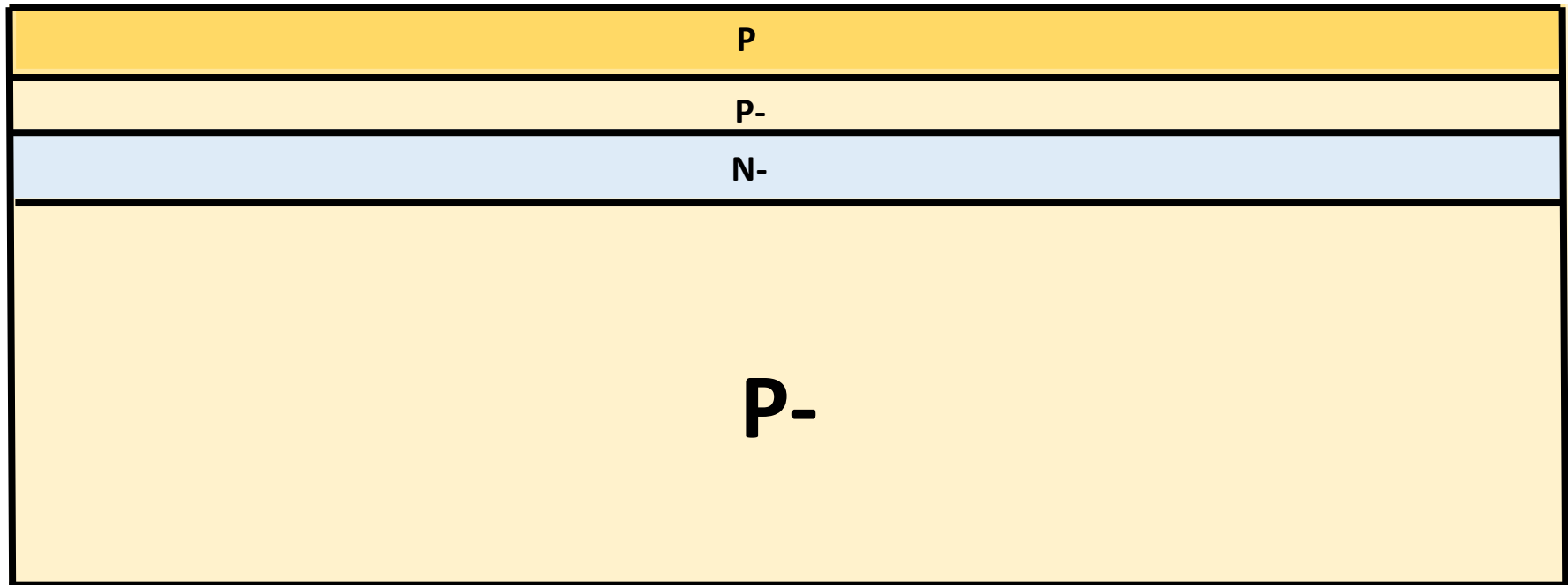


PP-N-P-P+ Double Junction Solar Cell

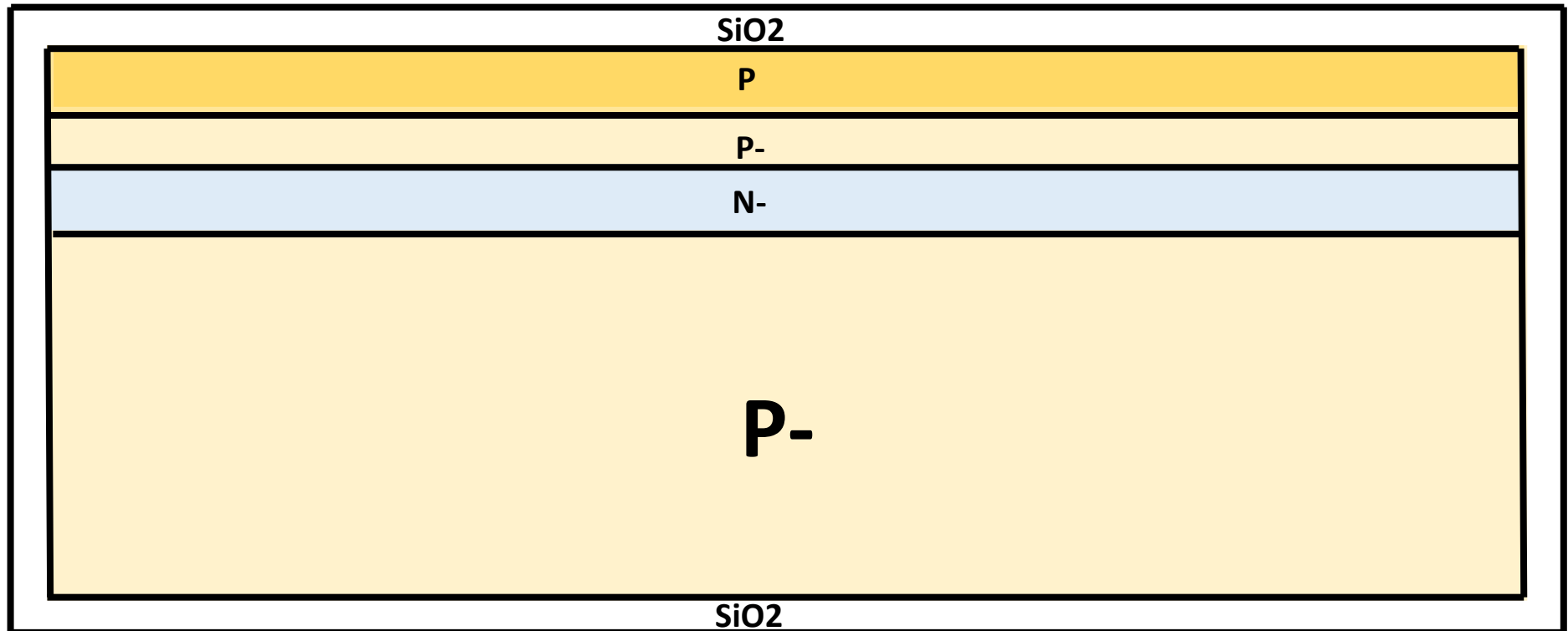
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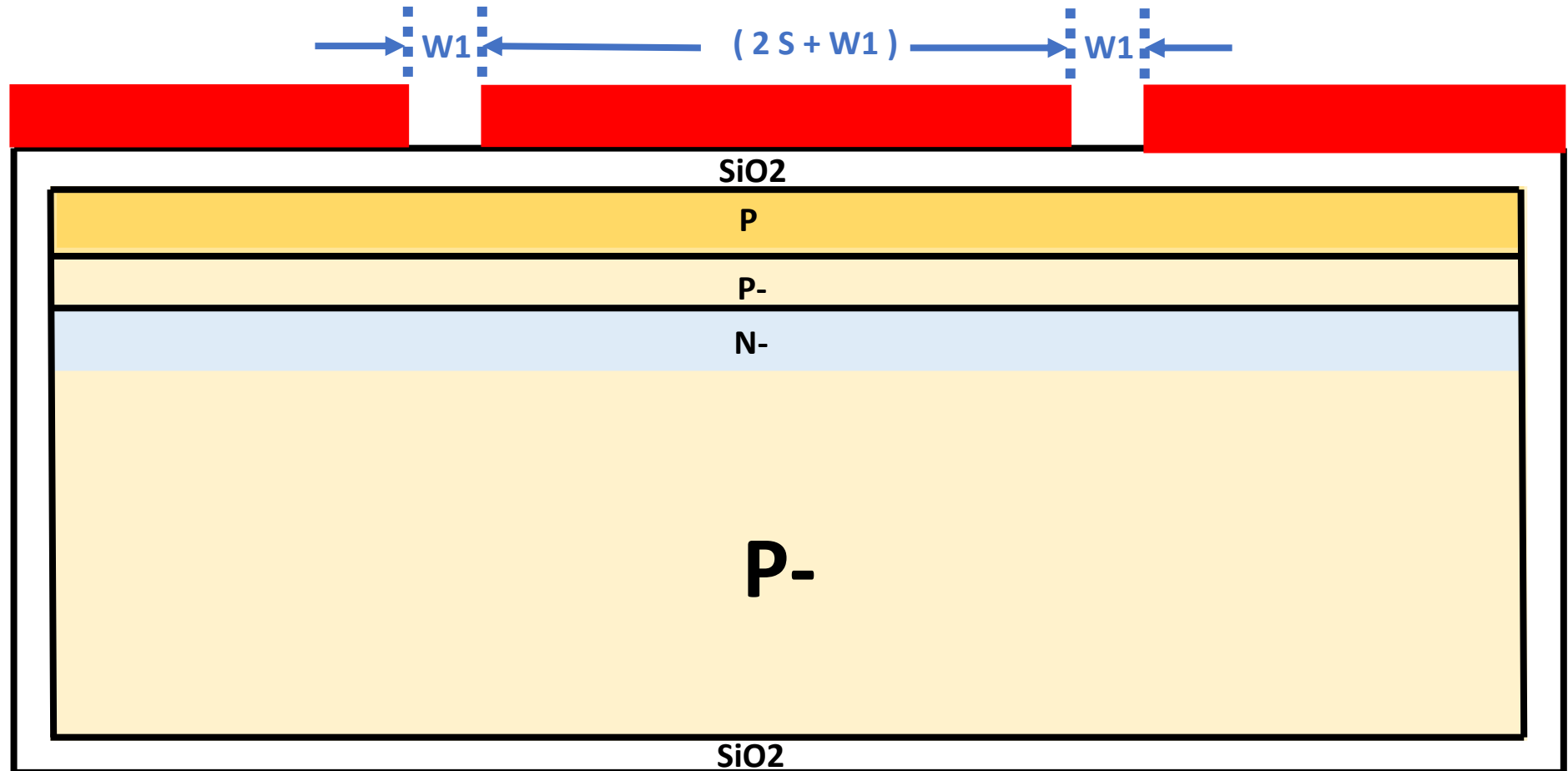
P01 Cleaning Silicon Wafer



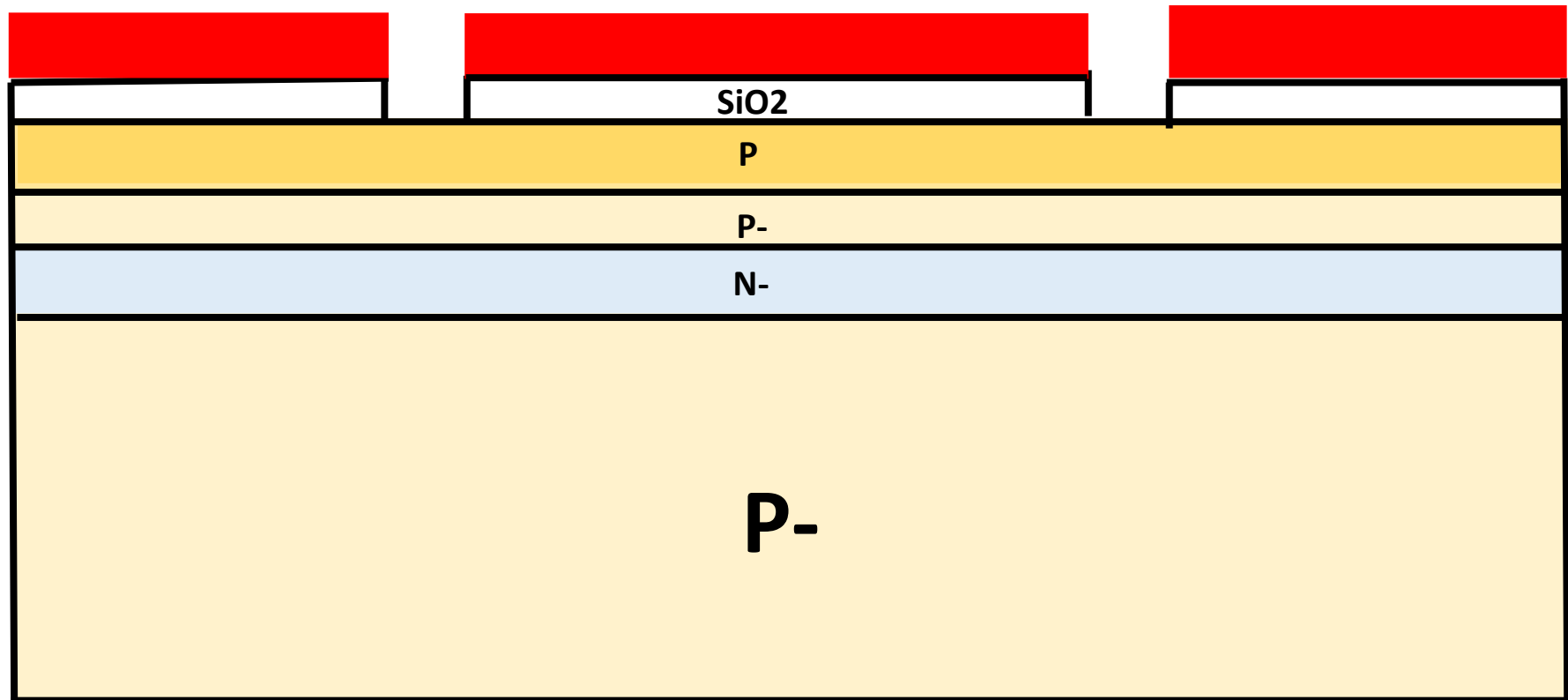
P02 First Oxidation



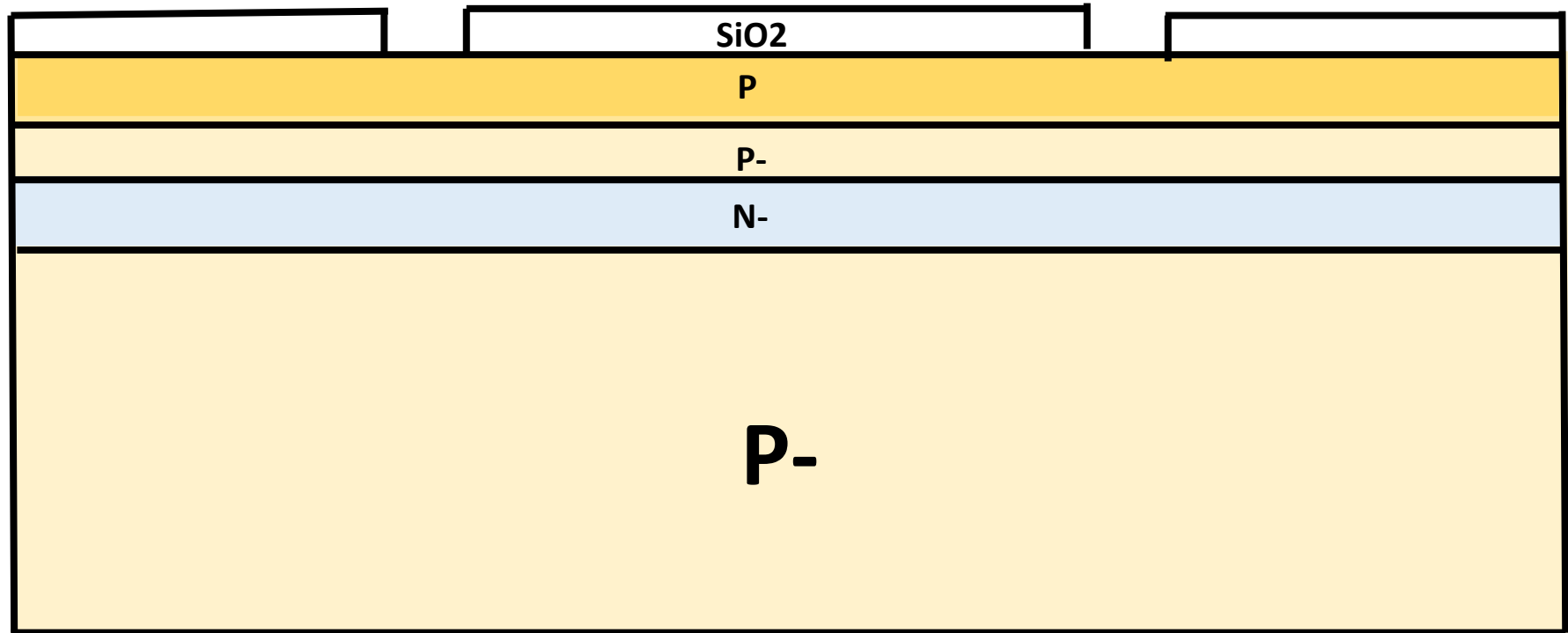
P03 Mask 01 First Resist Coating and Patterning



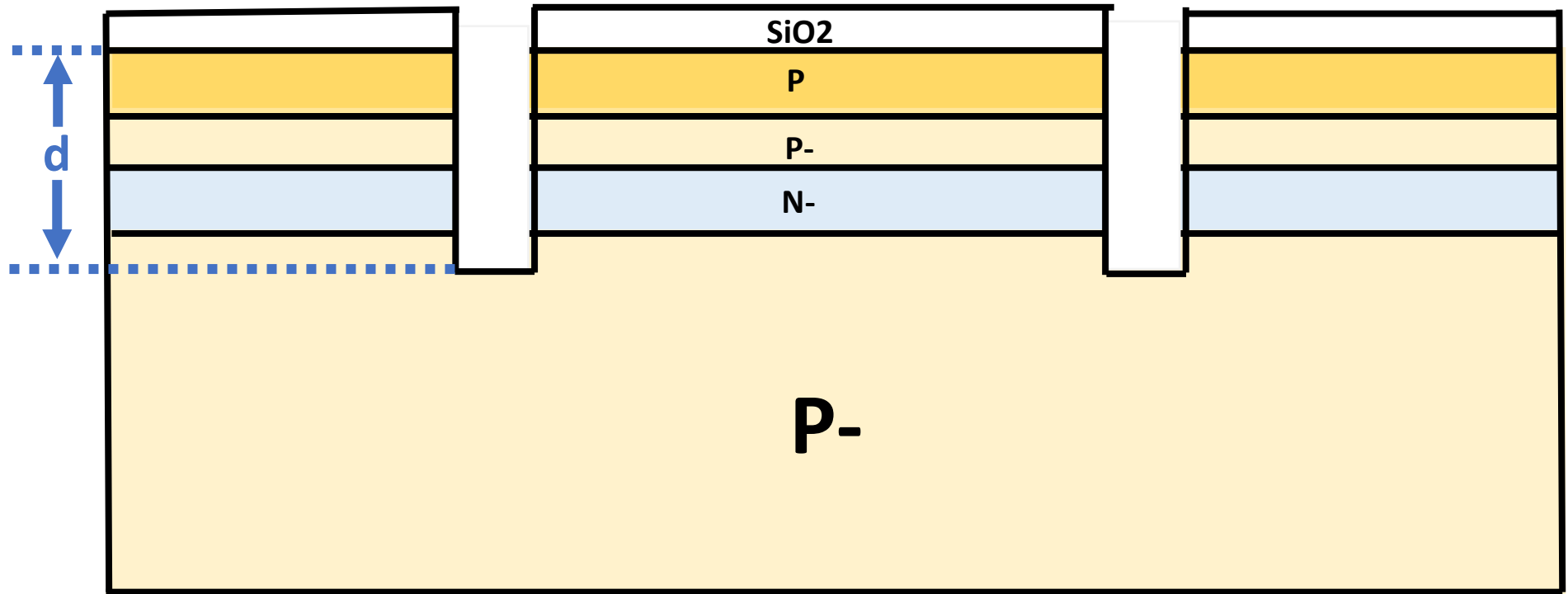
P04 First SiO₂ Etching



P05 Remove Resist

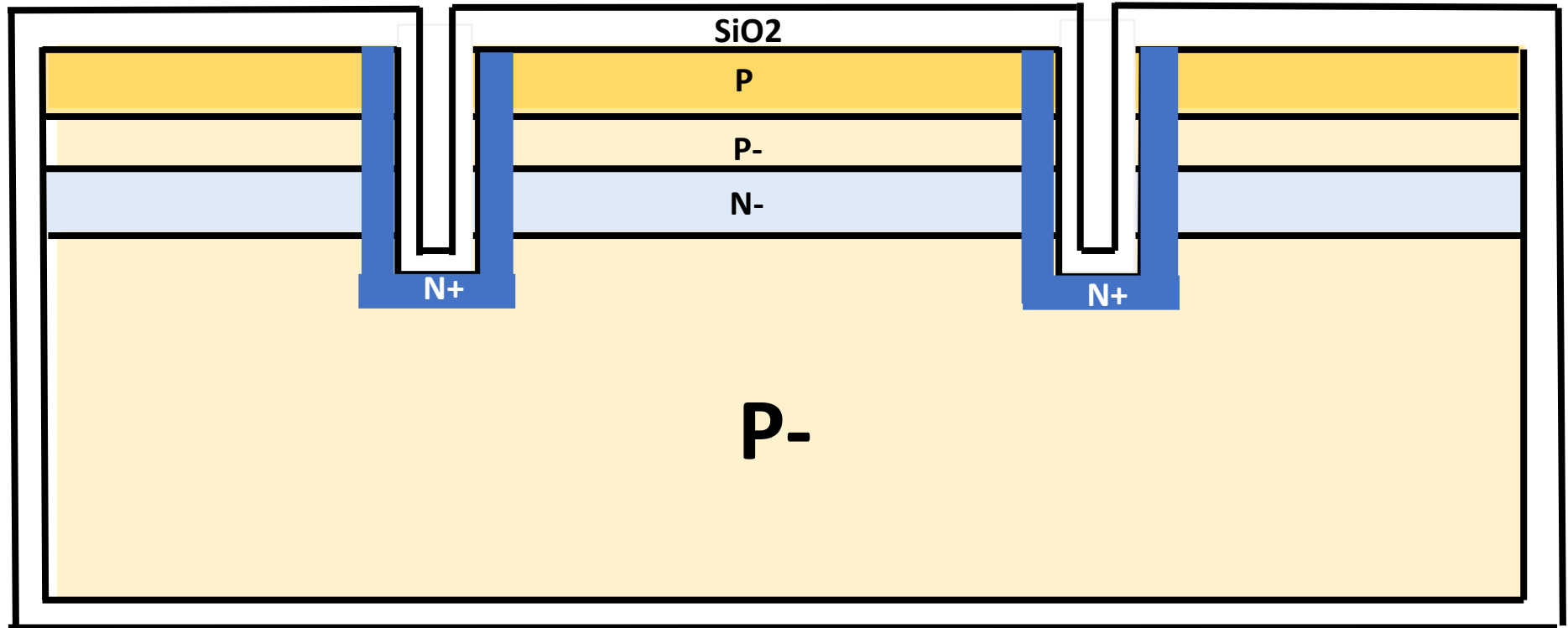


P06 Silicon KOH Etching

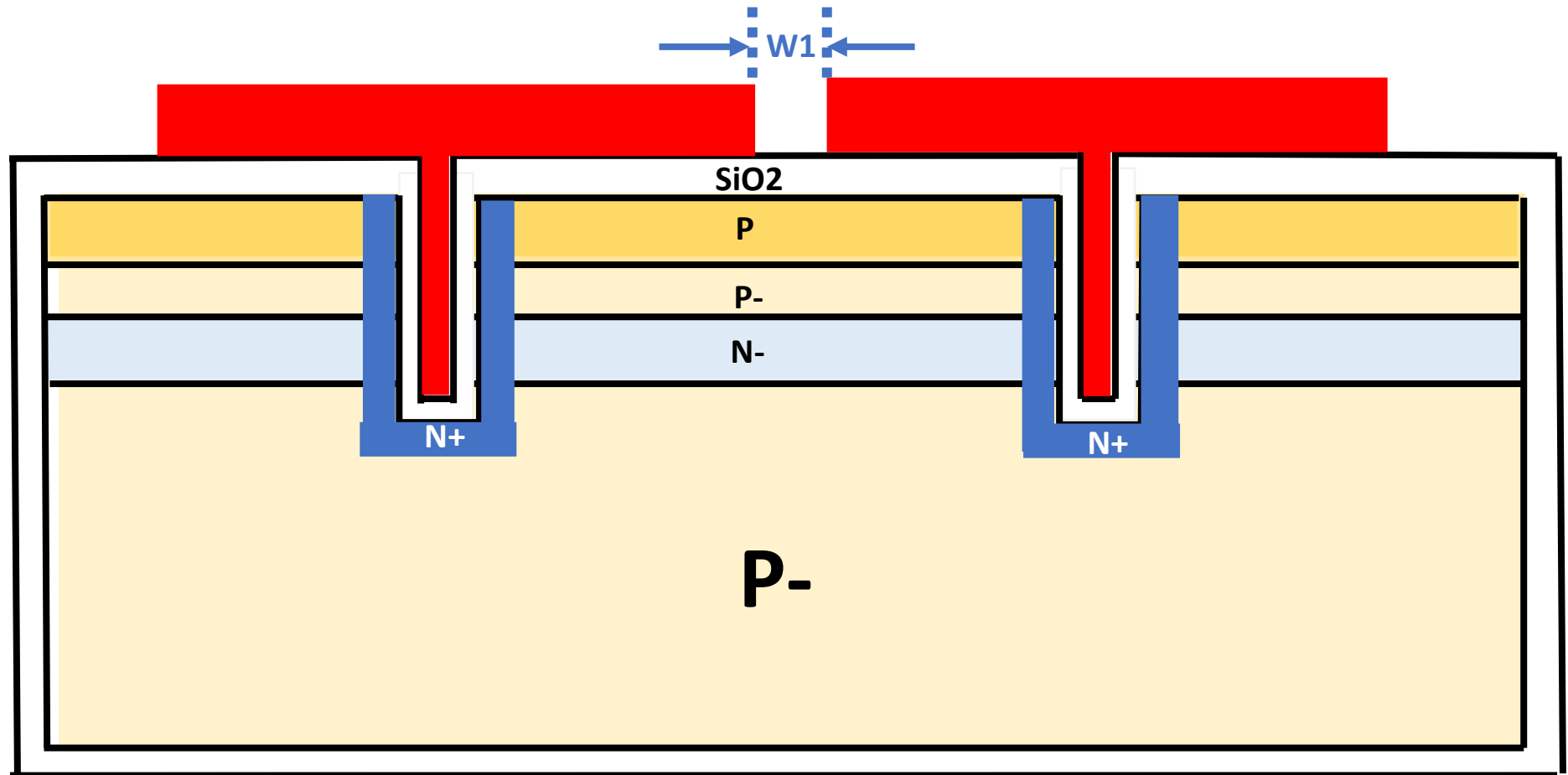


A cross-sectional diagram of a CMOS transistor. The substrate is a thick yellow layer labeled **P-**. On top of the substrate, there are two wells: a blue **N+** well on the left and a blue **N+** well on the right. Between these wells is a large yellow **P** region. The **P** region is divided into a top yellow **P** layer and a bottom yellow **P-** layer. The **N+** wells are also divided into a top blue **N-** layer and a bottom blue **N+** layer. The top of the device is covered by a white **SiO2** layer. A dashed blue line connects the **P-** label on the substrate to the **P-** layer in the center of the device.

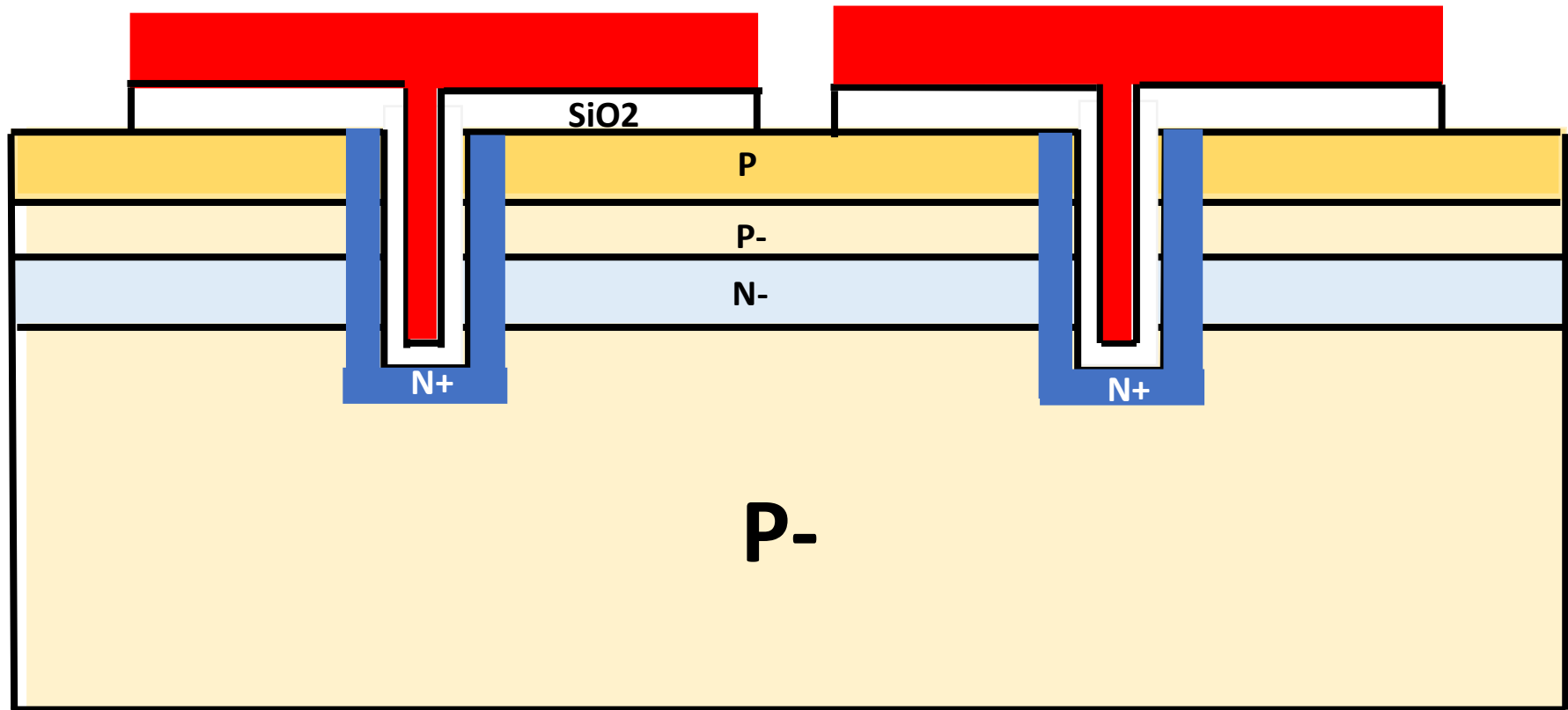
P08 Remove SiO₂ and Second Oxidation



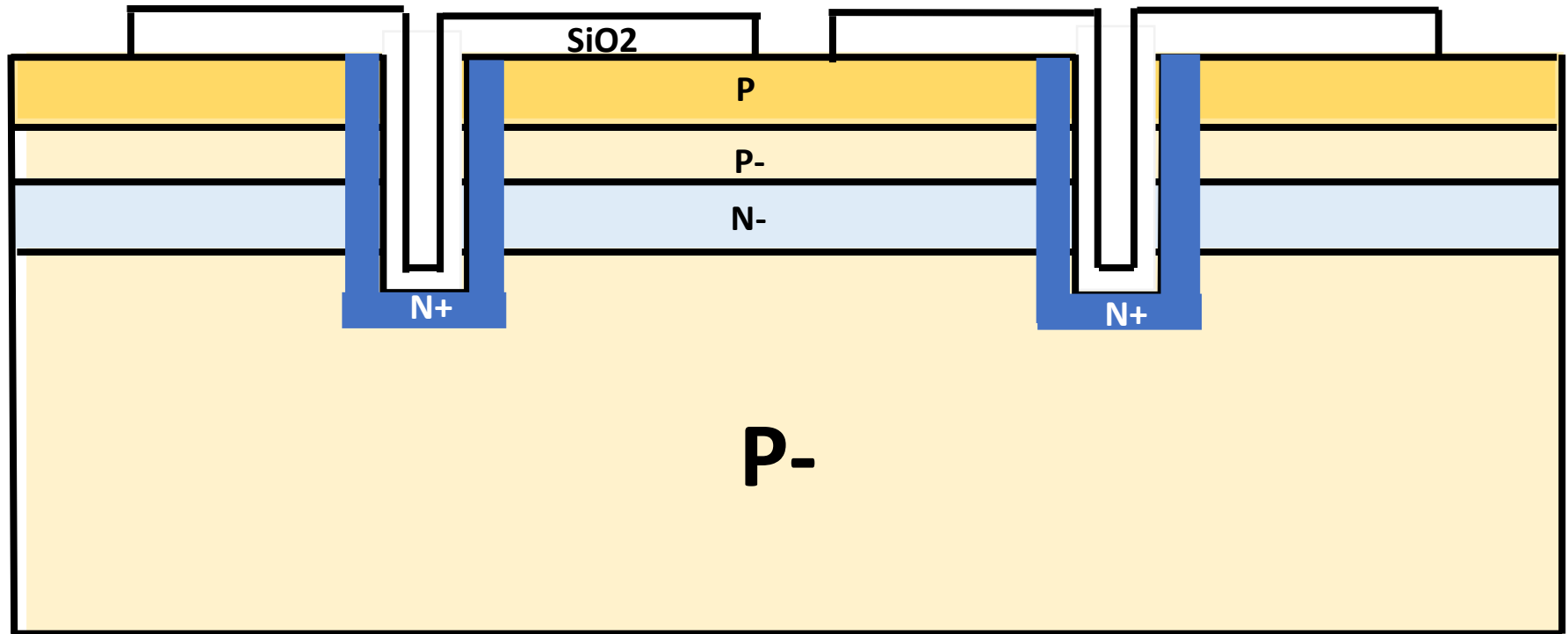
P09 Mask 02 Second Resist Coating and Patterning



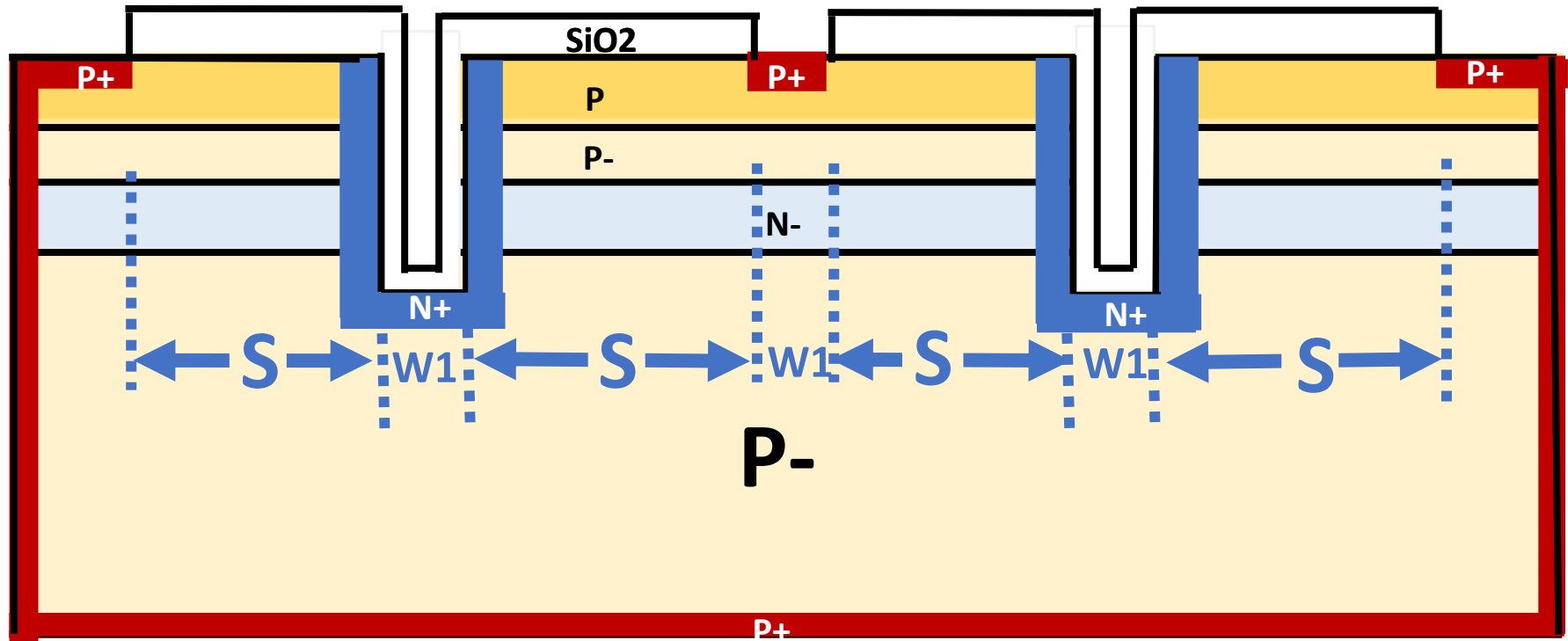
P10 Second SiO₂ Etching



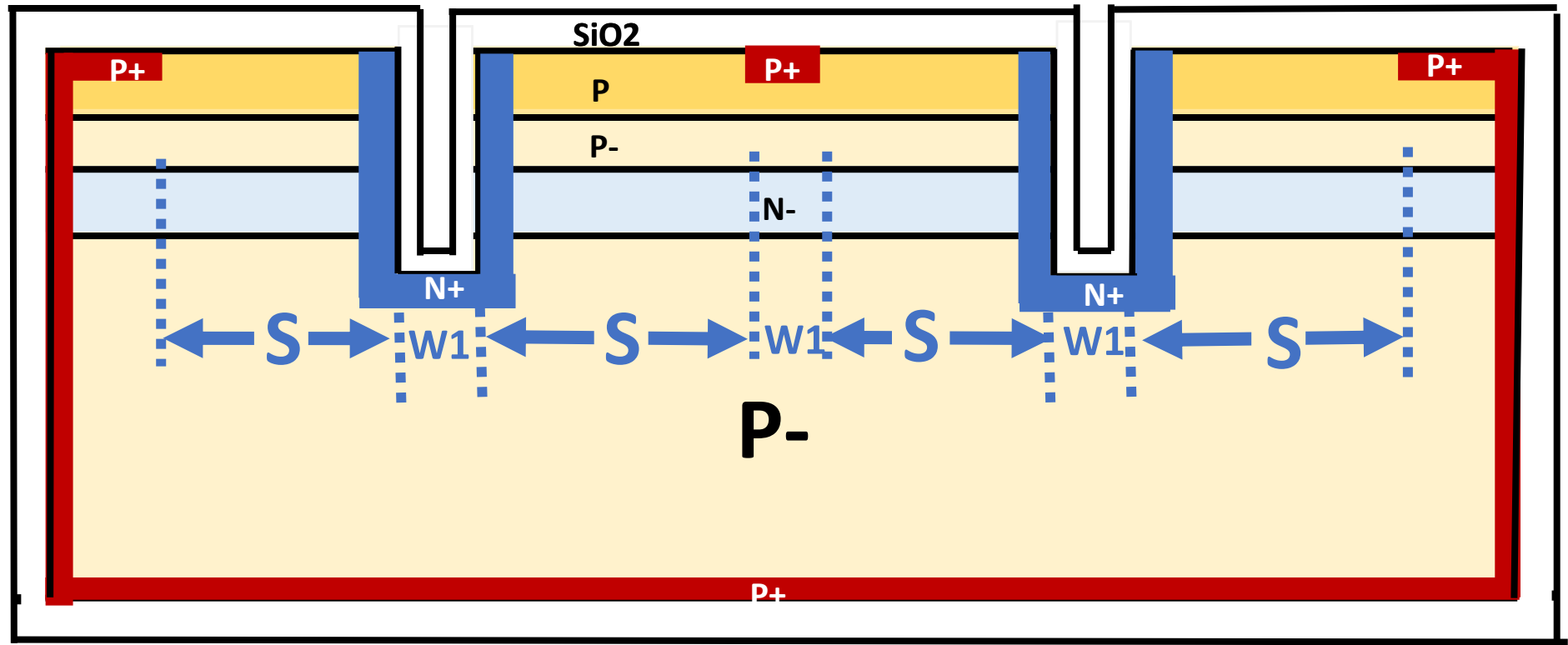
P11 Remove Resist



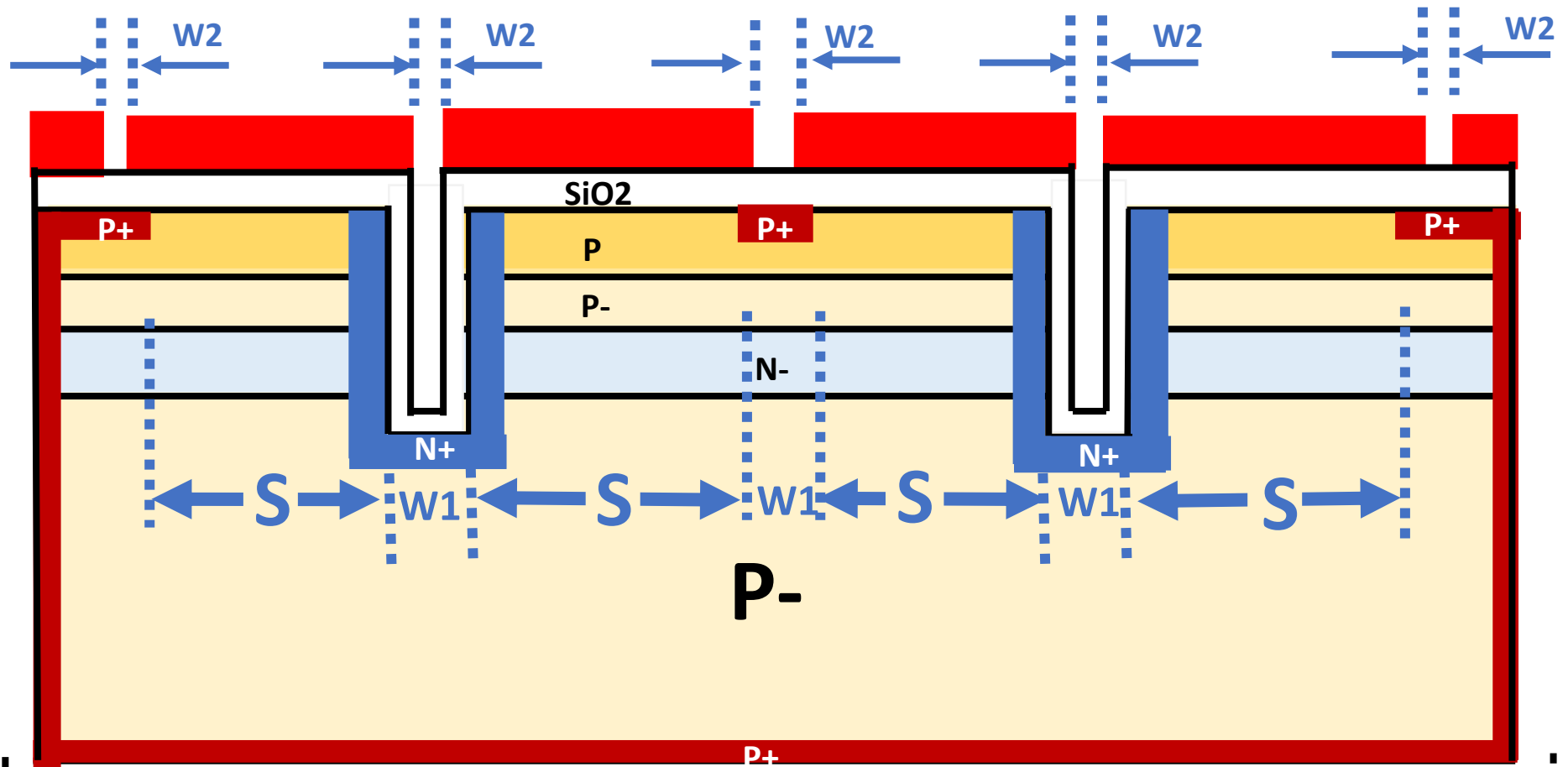
P12 PBF Coating and P+ Diffusion



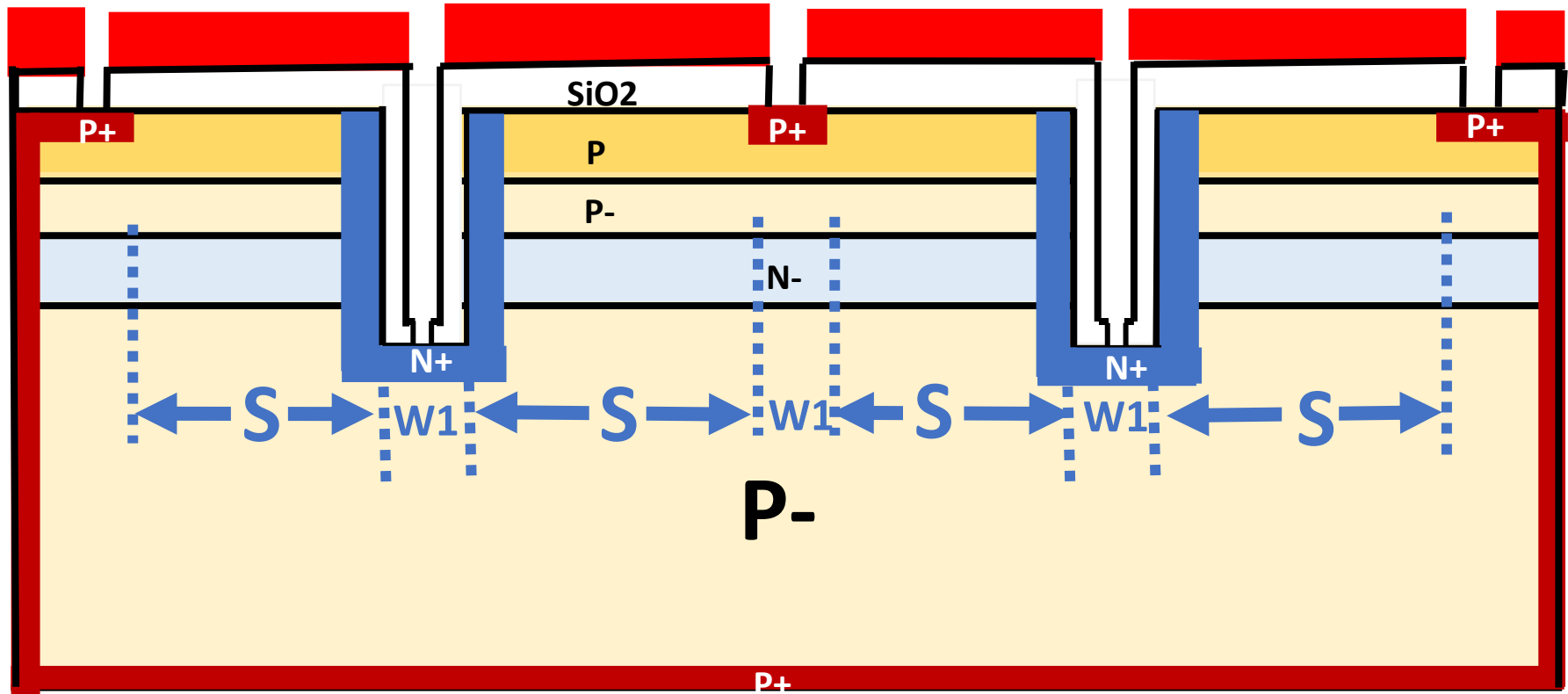
P13 Remove SiO₂ and Third Oxidation



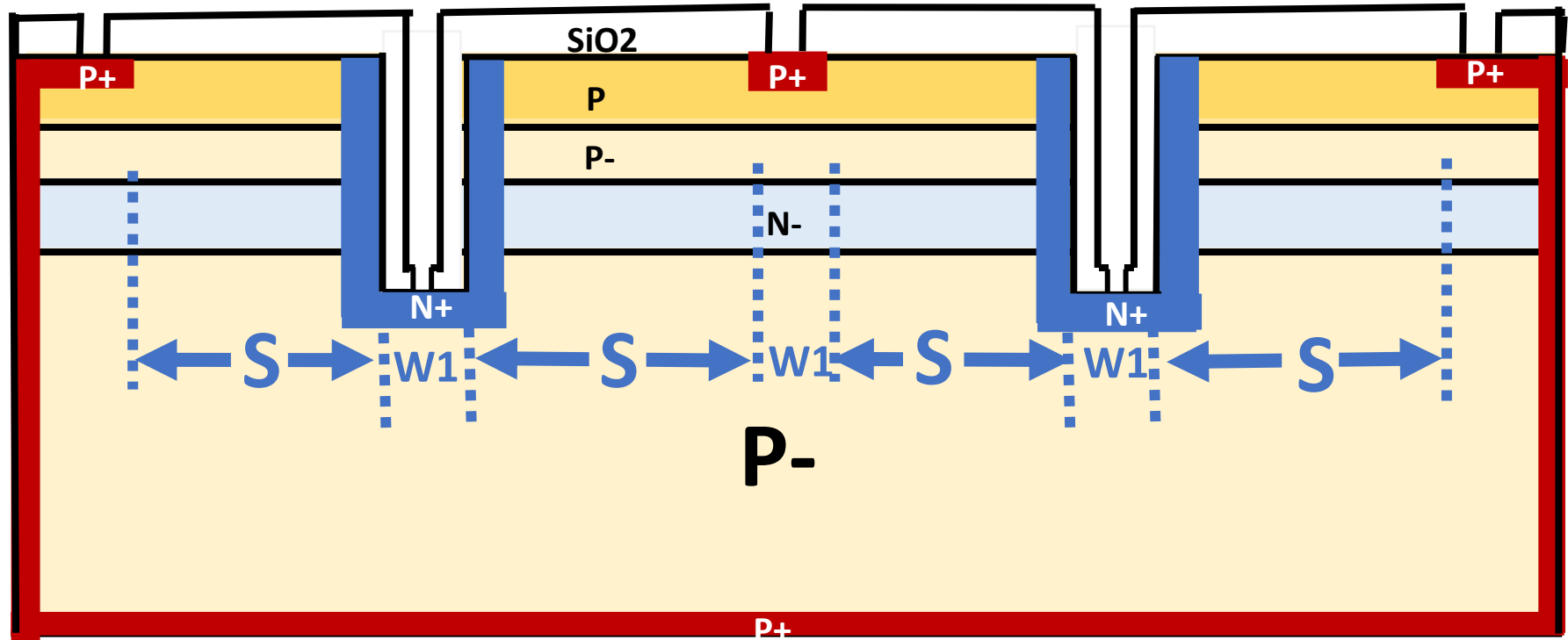
P14 Mask03 Third Resist Coating and Patterning



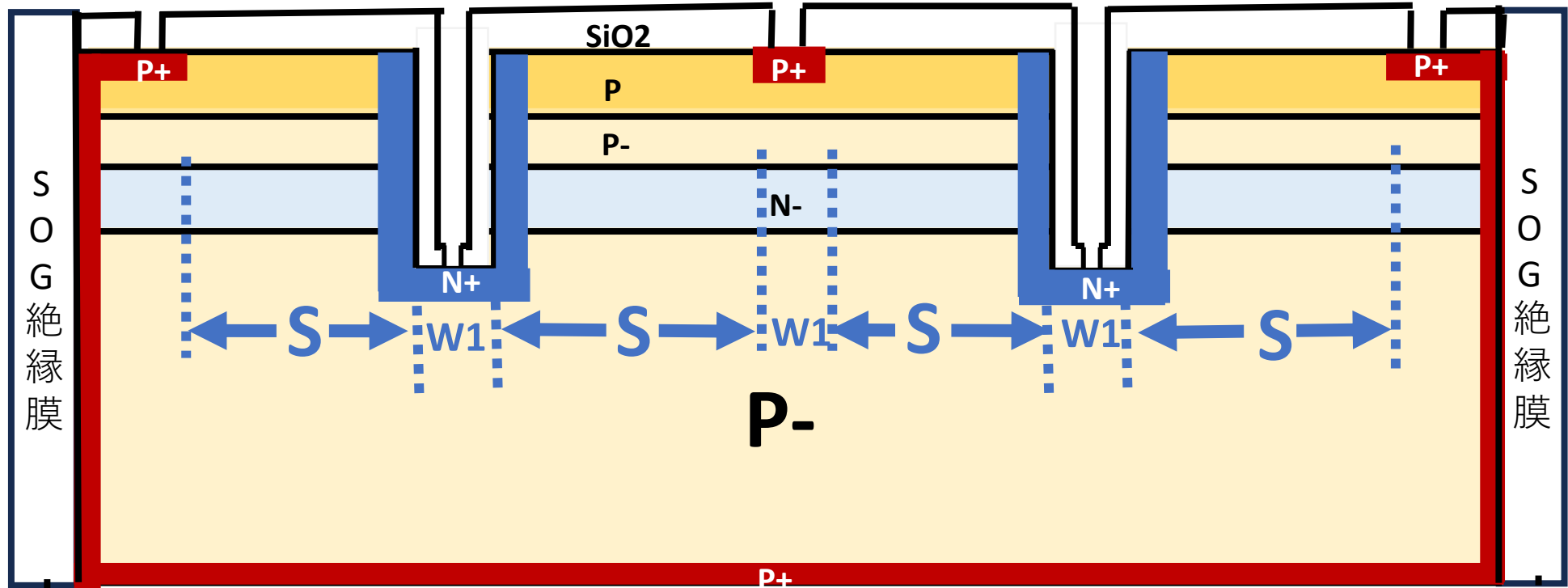
P15 SiO₂ Etching



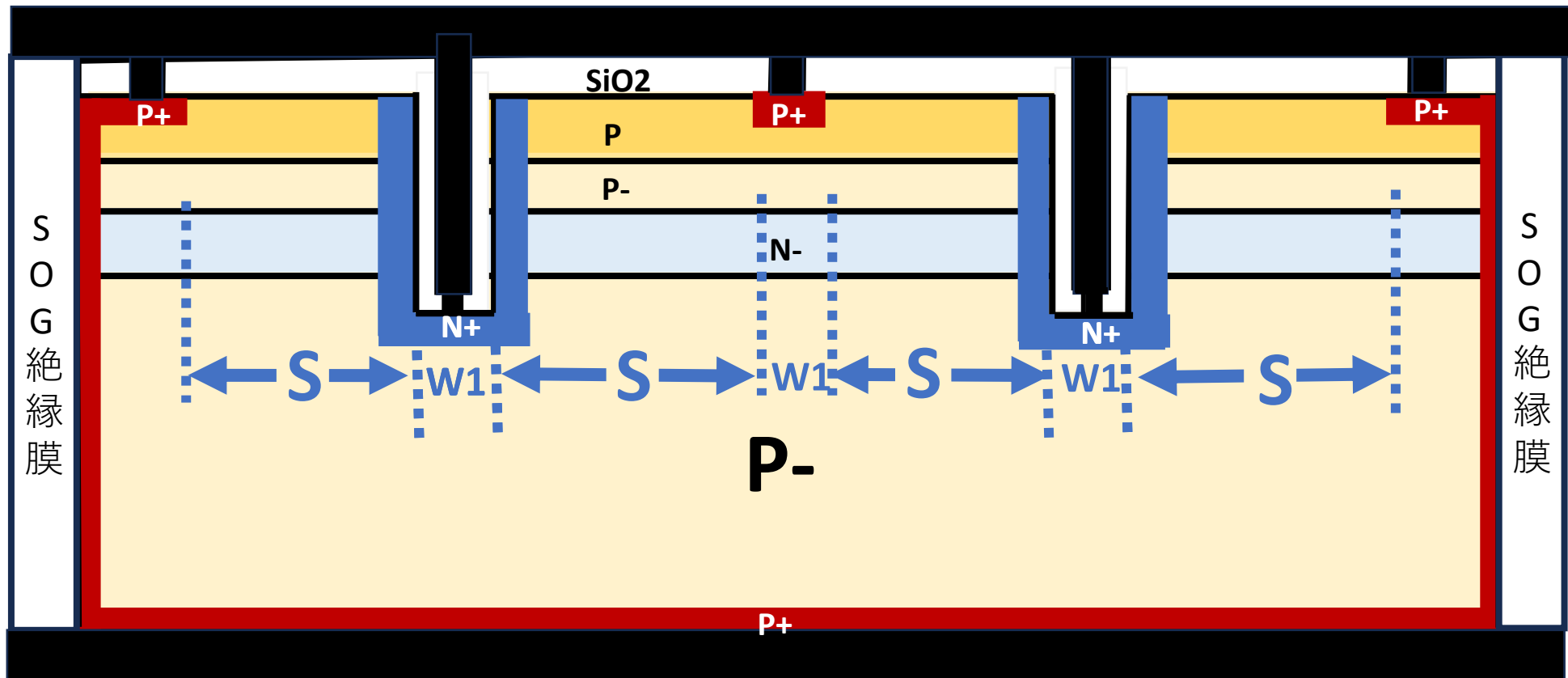
P16 Remove Resist



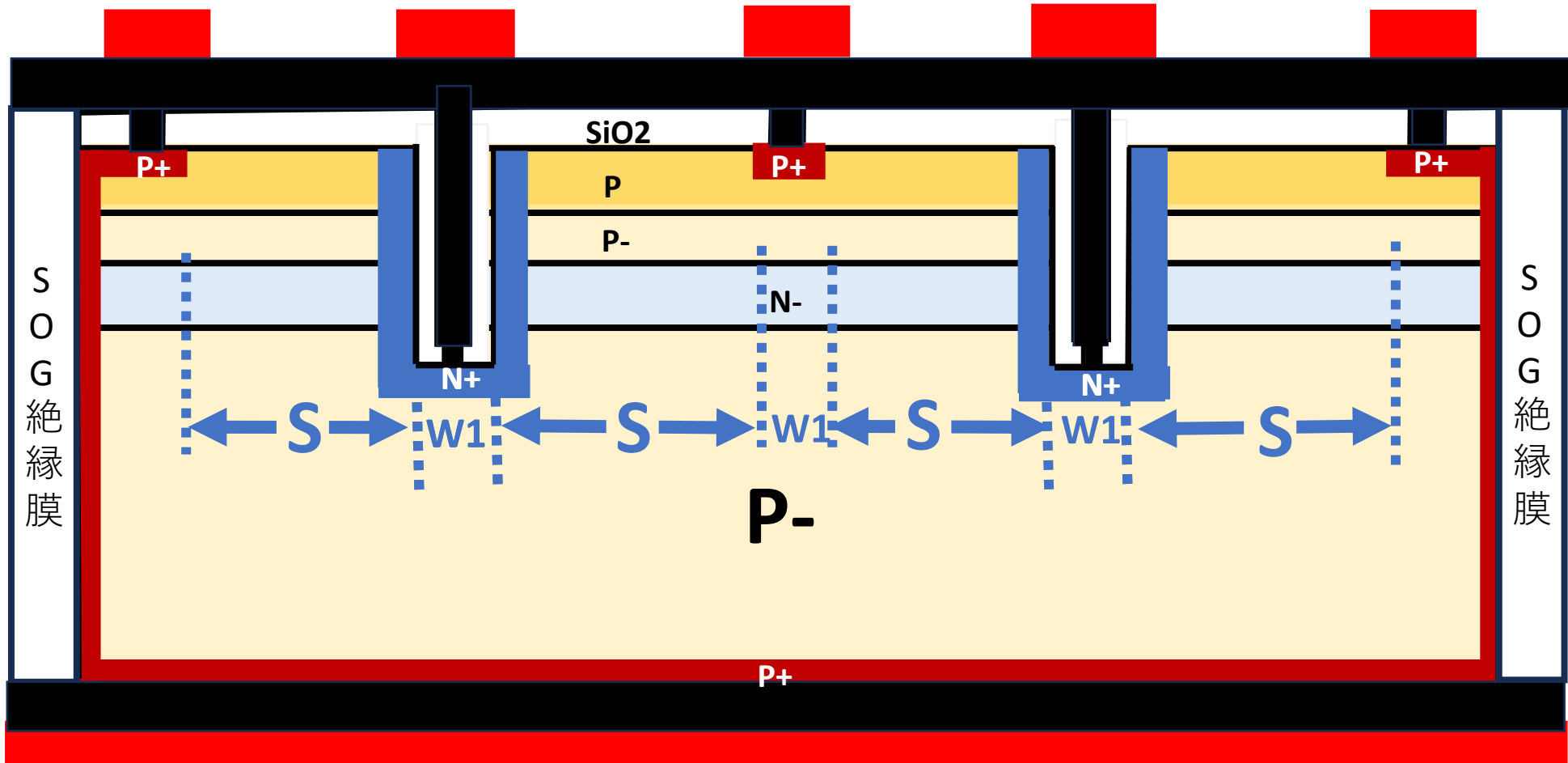
P17 SOG Side Coating



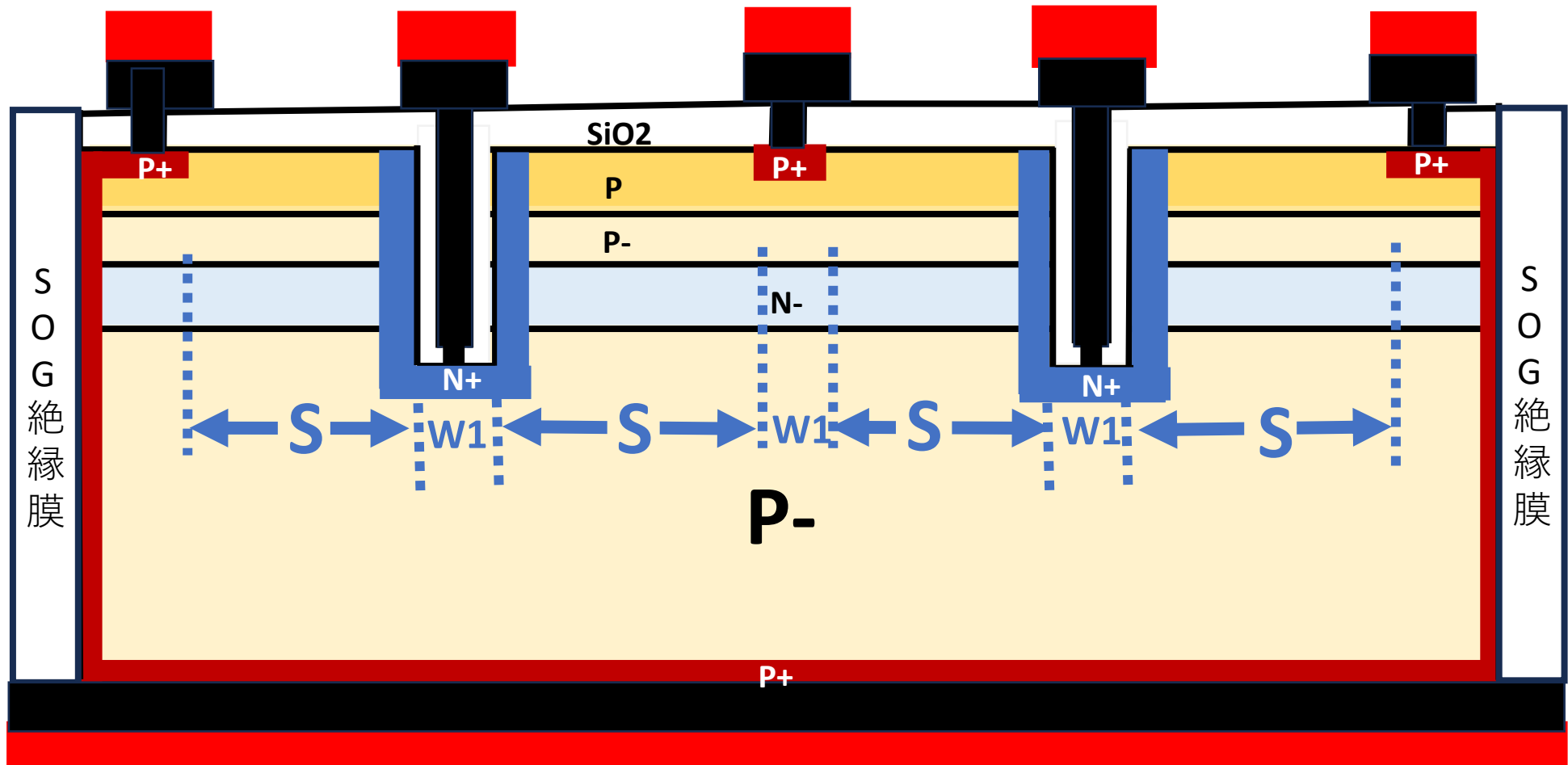
P18 Metal Deposit



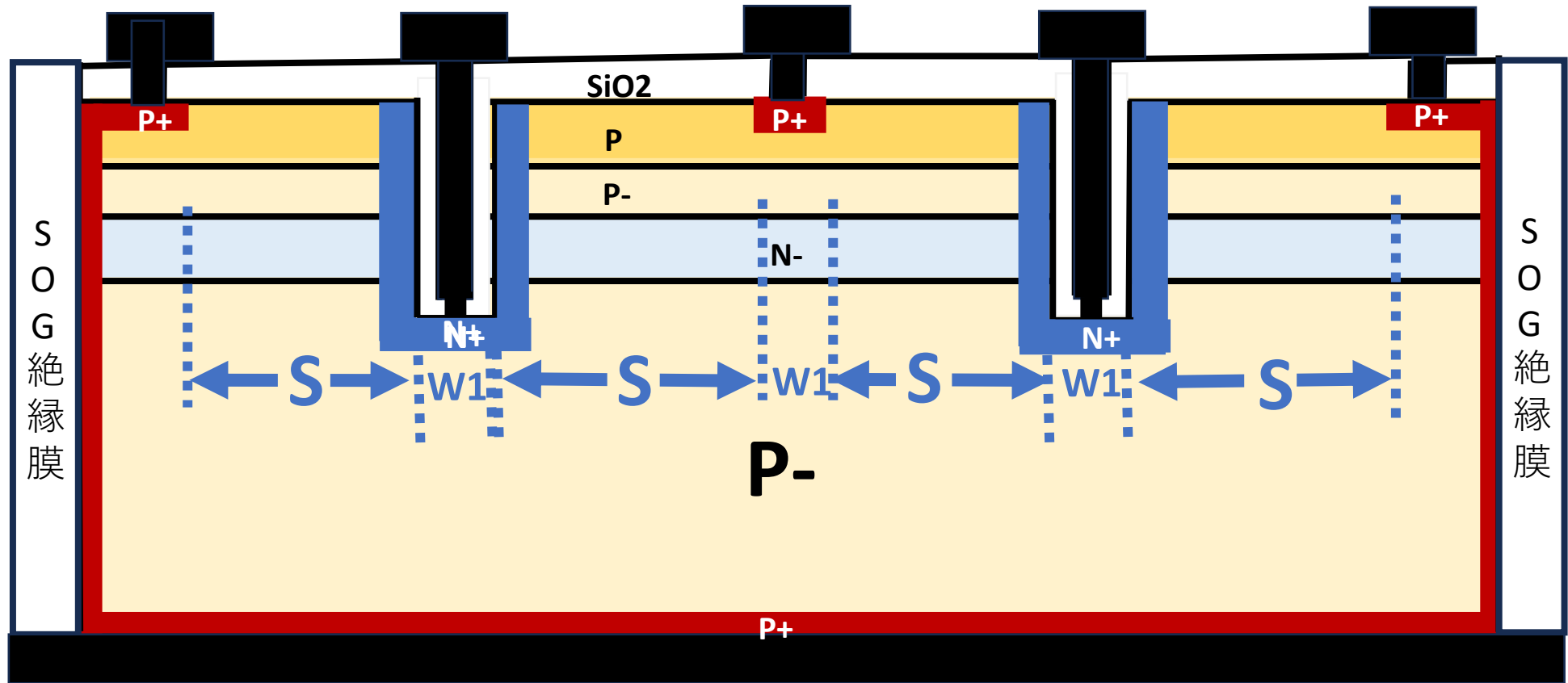
P19 MASK04 Resist Coating and Patterning



P20 Metal Etching



P21 Remove Resist



PP-N-P-P+ Double Junction Solar Cell

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