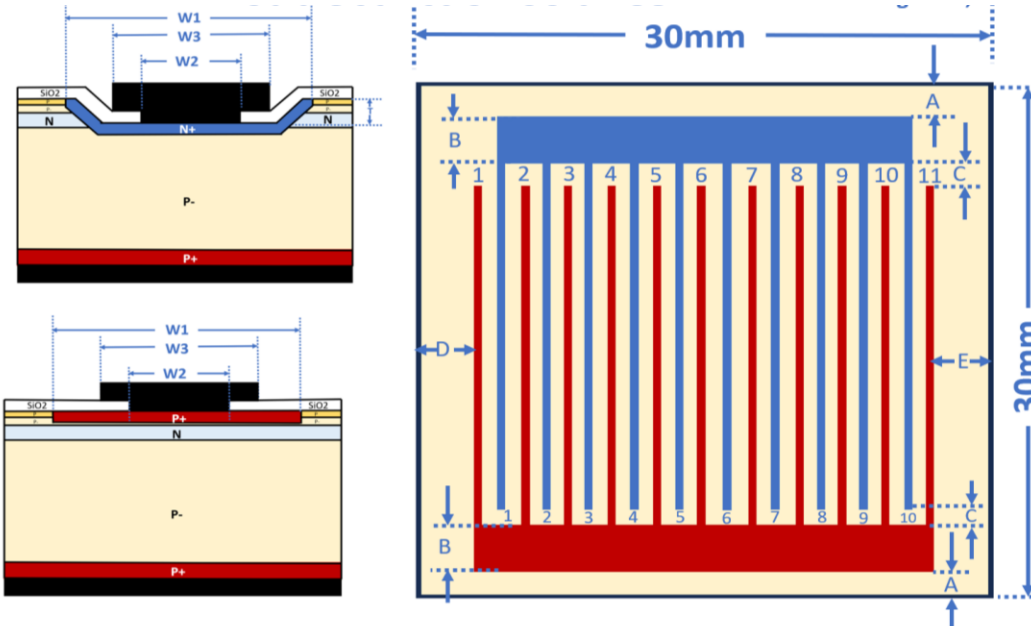


PP-N-P-P+ Double Junction Solar Cell

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) :

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

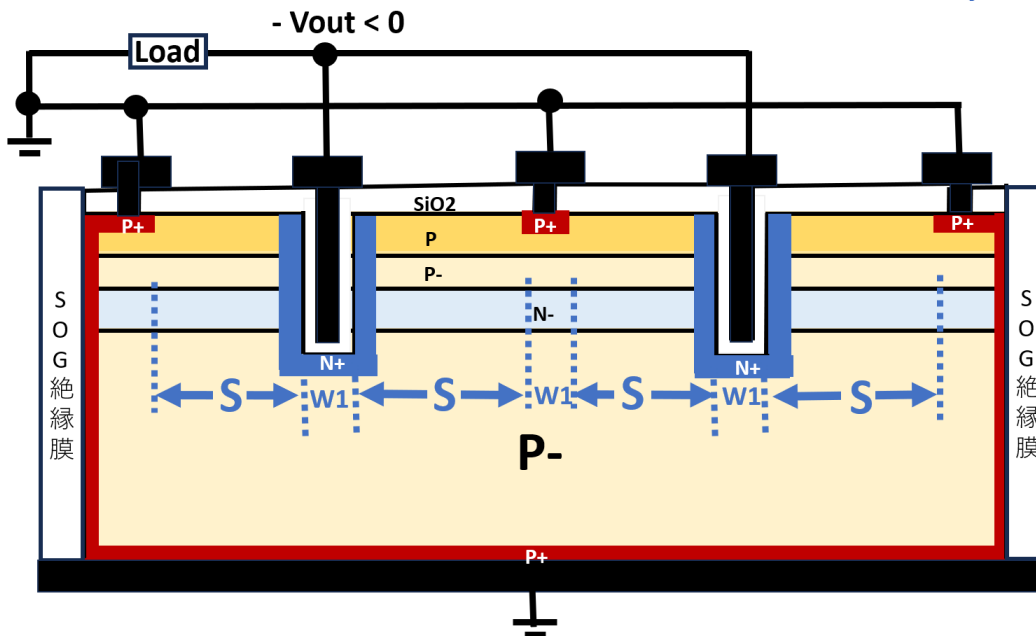
$$S = (30 - D - E - 21 * W1) / 20 ;$$

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

Choose S = 1.1 and W1 = 0.3.

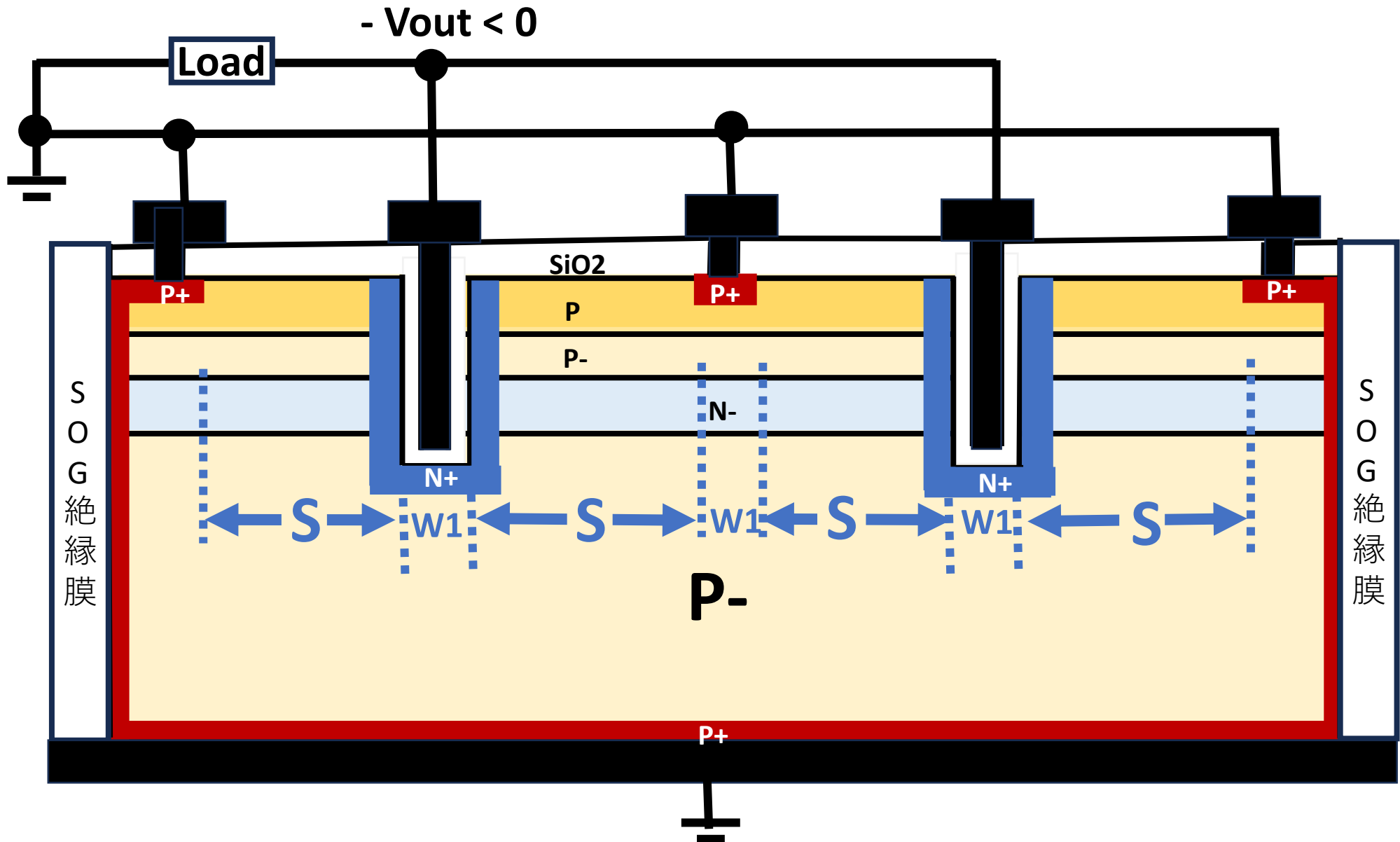
We have (D + E) = 8 - 6.3 = 1.7

Choose D= 0.9 and E = 0.8.



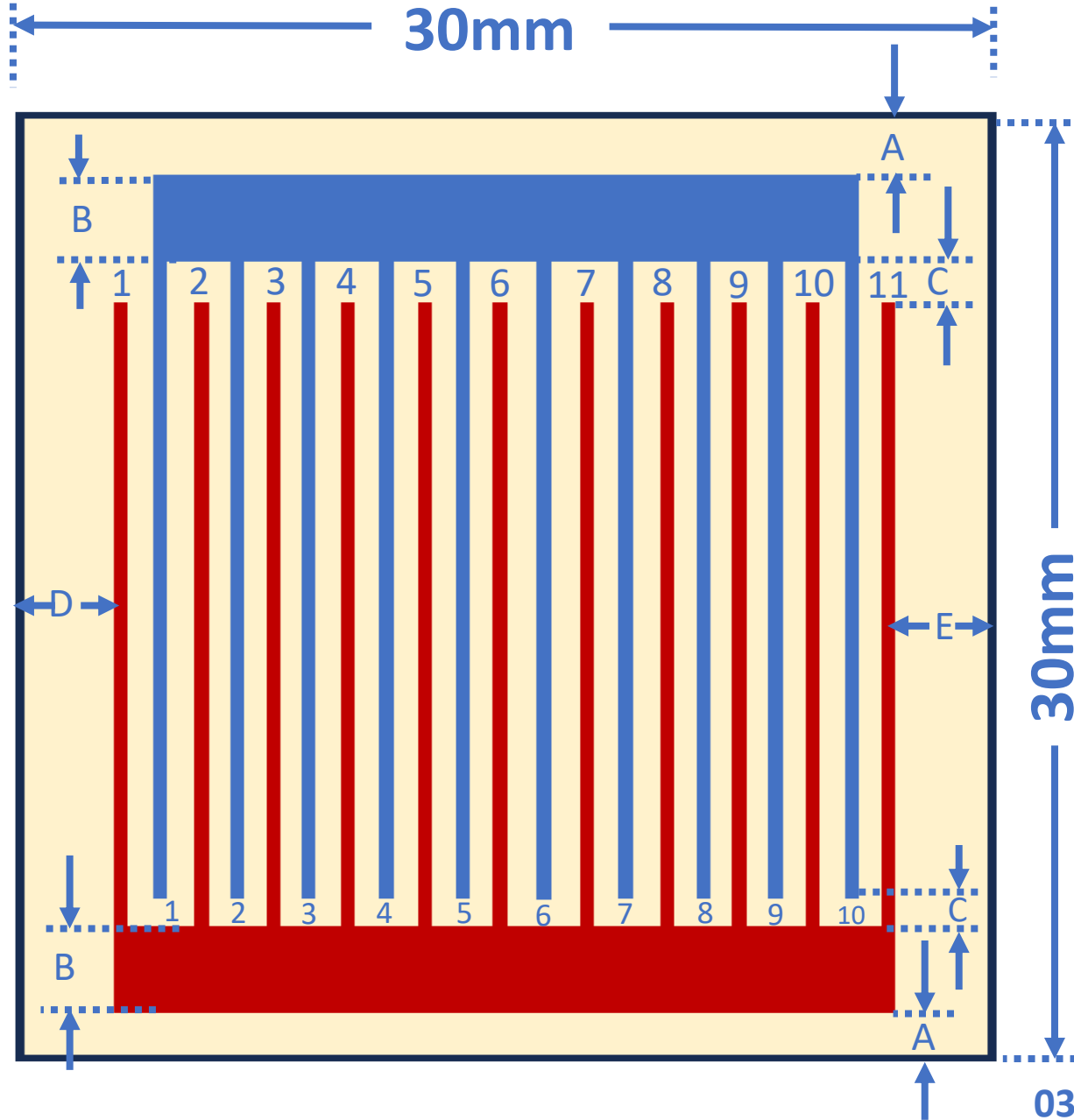
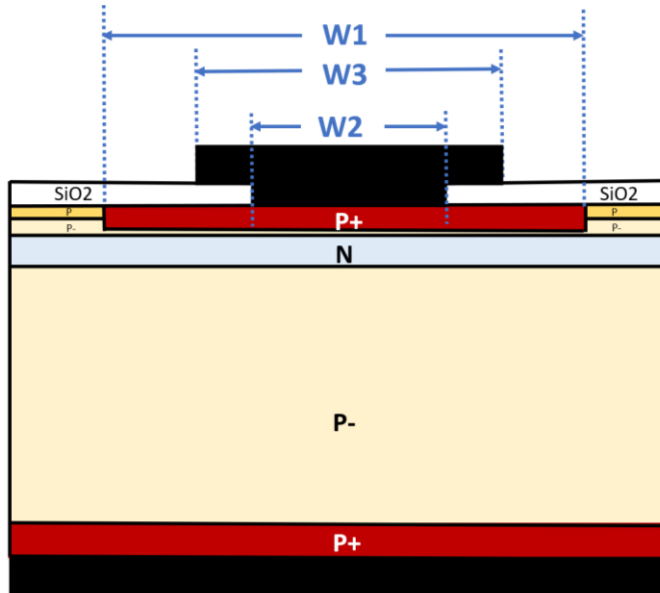
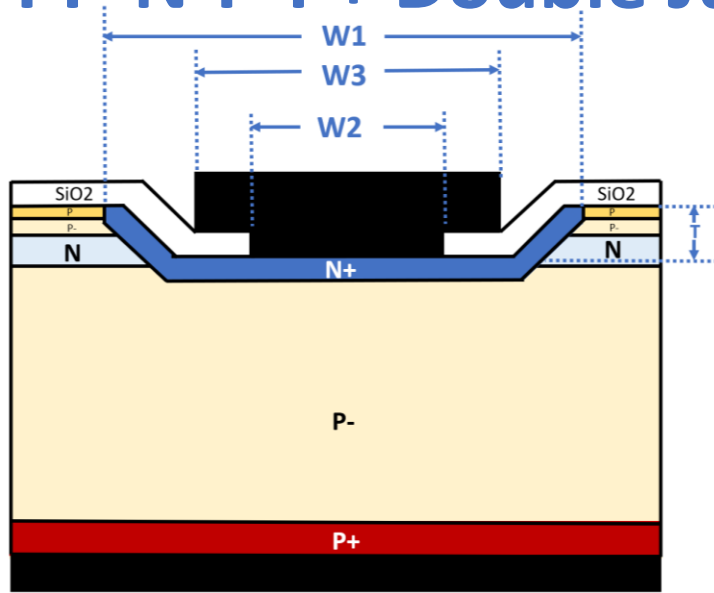
PP-N-P-P+ Double Junction Solar Cell

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

Yoshiaki Hagiwara, AIPS



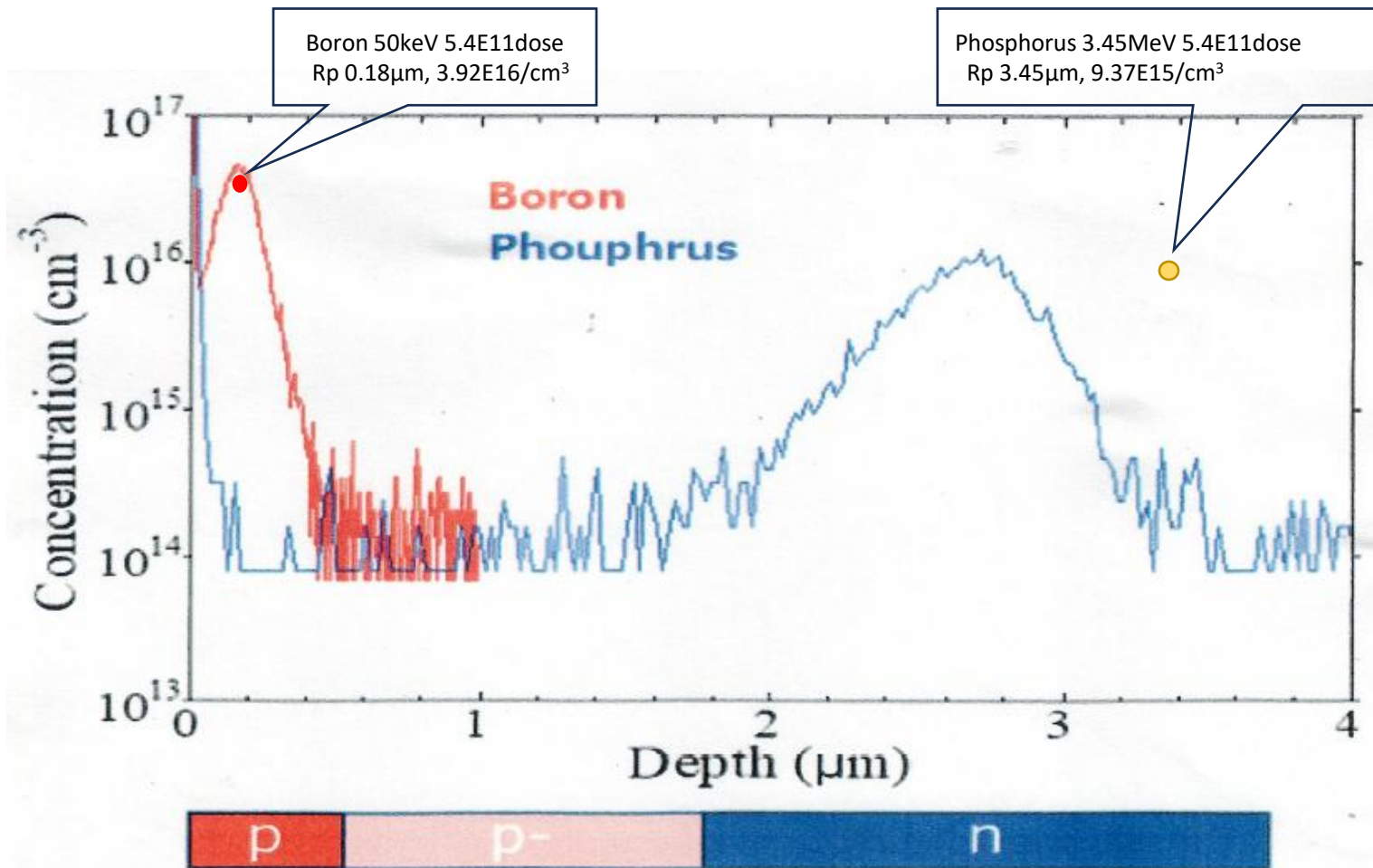


Fig.9 Impurity Doping Profile of Fabricated PP-NP- Junction Sample

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)	ΔRp (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)	ΔRp (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

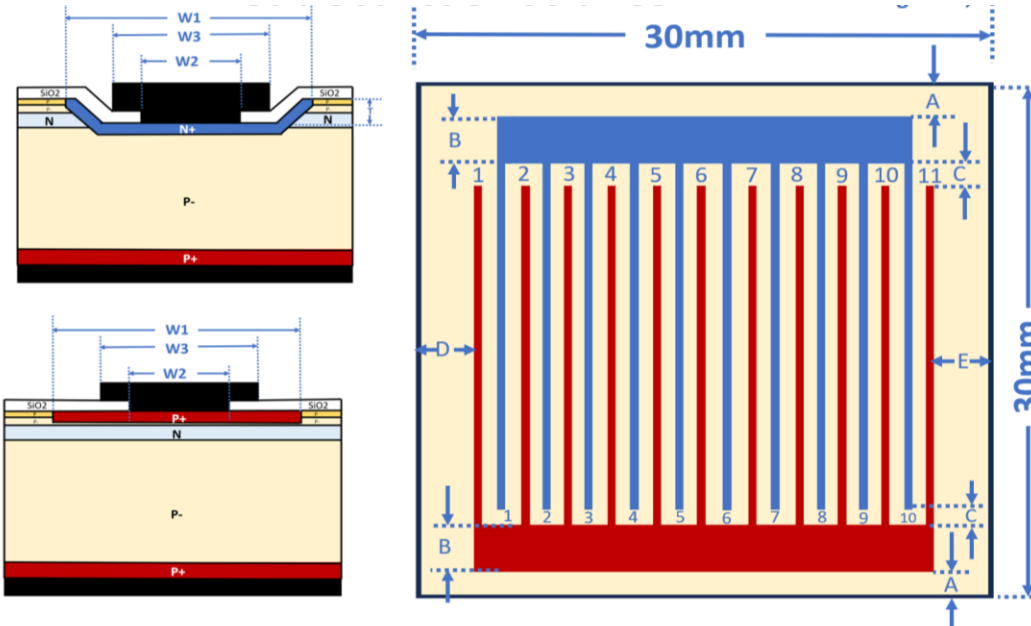
Dose (cm^{-2})	Peak Depth Rp (μm)	ΔRp (μm)	Peak Concentration (cm^{-3})
1.8×10^{10}	3.45	0.567	1.27×10^{14}
5.4×10^{10}	3.45	0.567	3.80×10^{14}
1.8×10^{11}	3.45	0.567	1.27×10^{15}
5.4×10^{11}	3.45	0.567	3.80×10^{15}

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) :

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

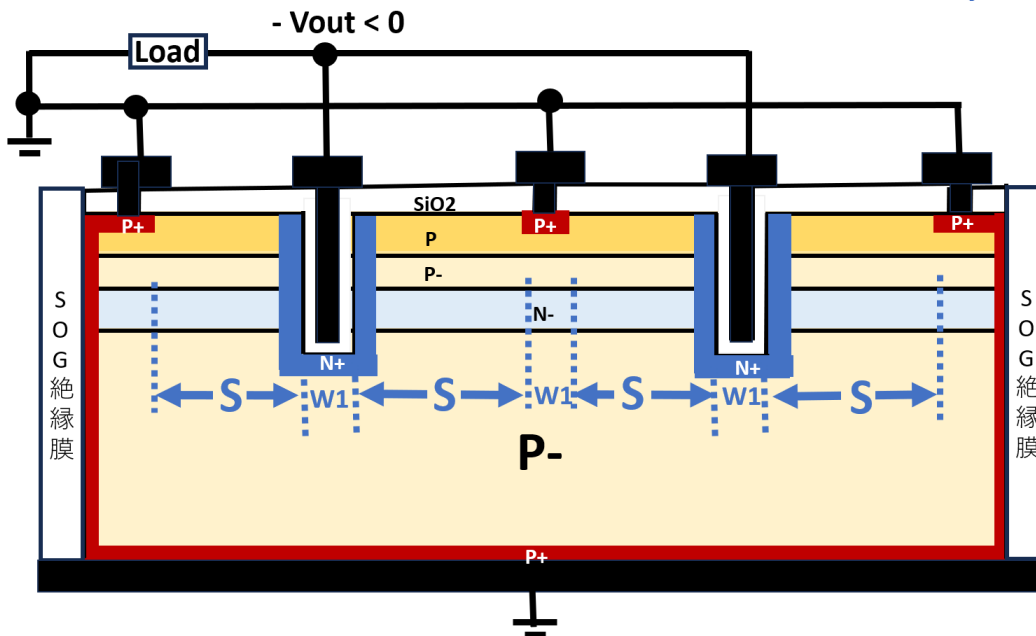
$$S = (30 - D - E - 21 * W1) / 20 ;$$

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

Choose S = 1.1 and W1 = 0.3.

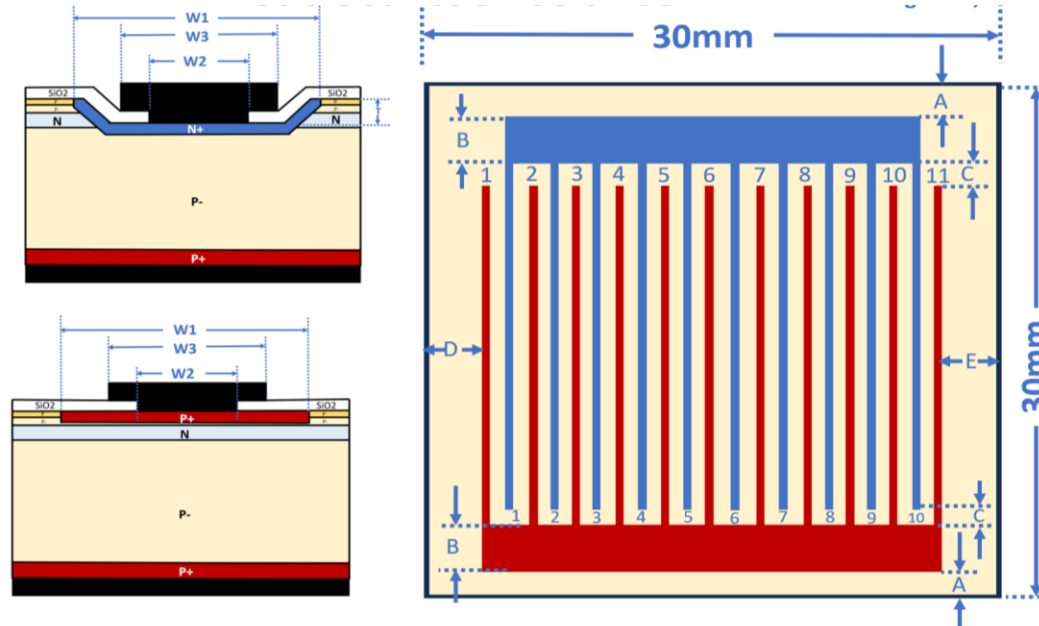
We have (D + E) = 8 - 6.3 = 1.7

Choose D= 0.9 and E = 0.8.



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

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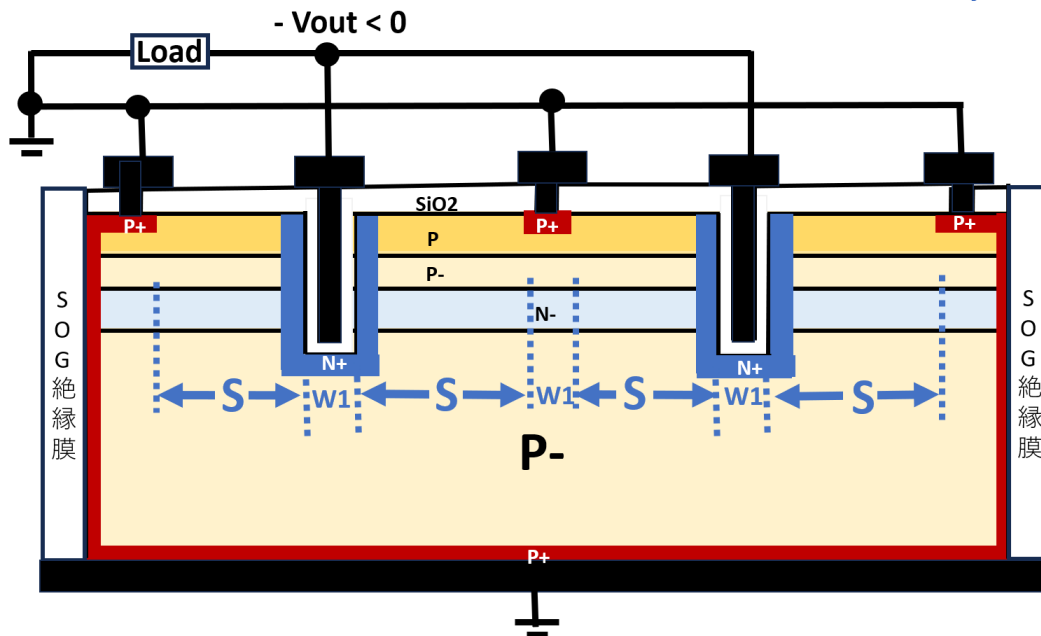


$A=1; B=1; C=1; D=0.9; E=0.8; L=25;$
 $W1=0.3; W2=0.1; W3=0.2; S=1.1;$

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

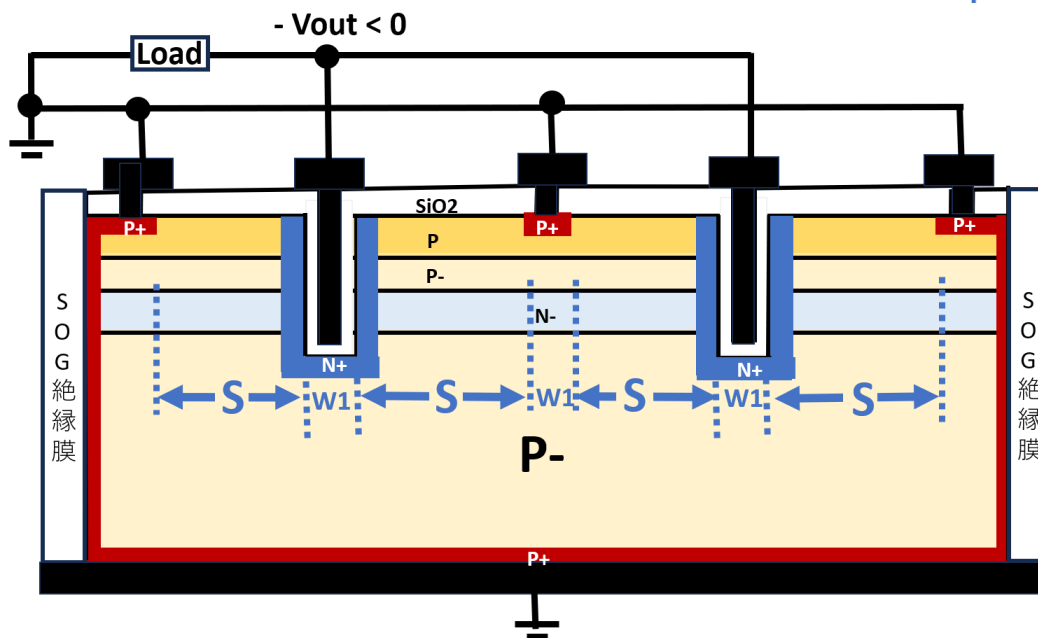
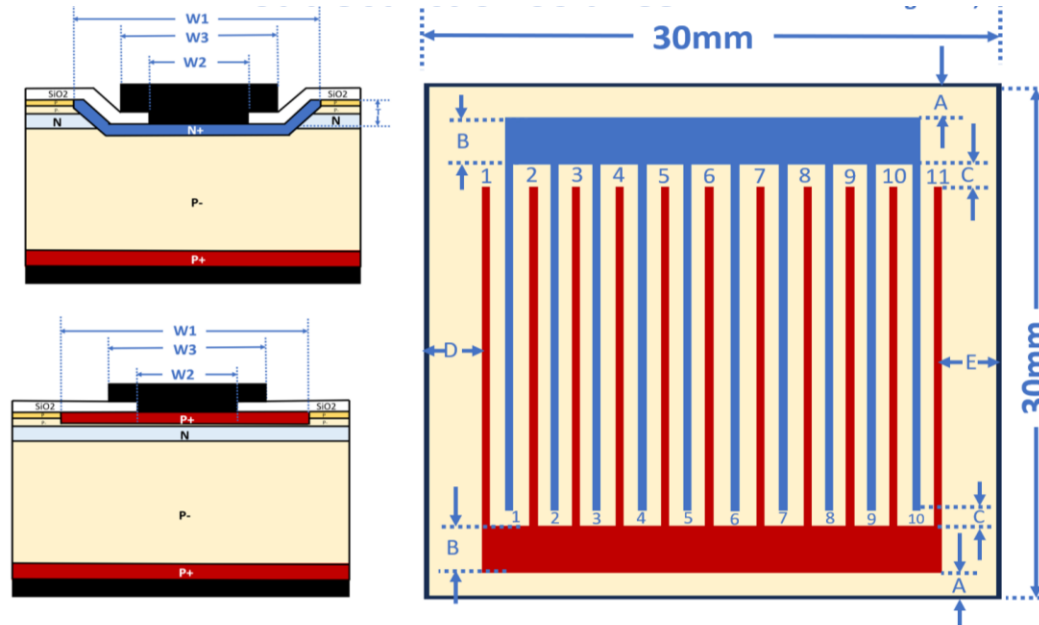


PP-N-P-P+ Double Junction Solar Cell

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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 *****

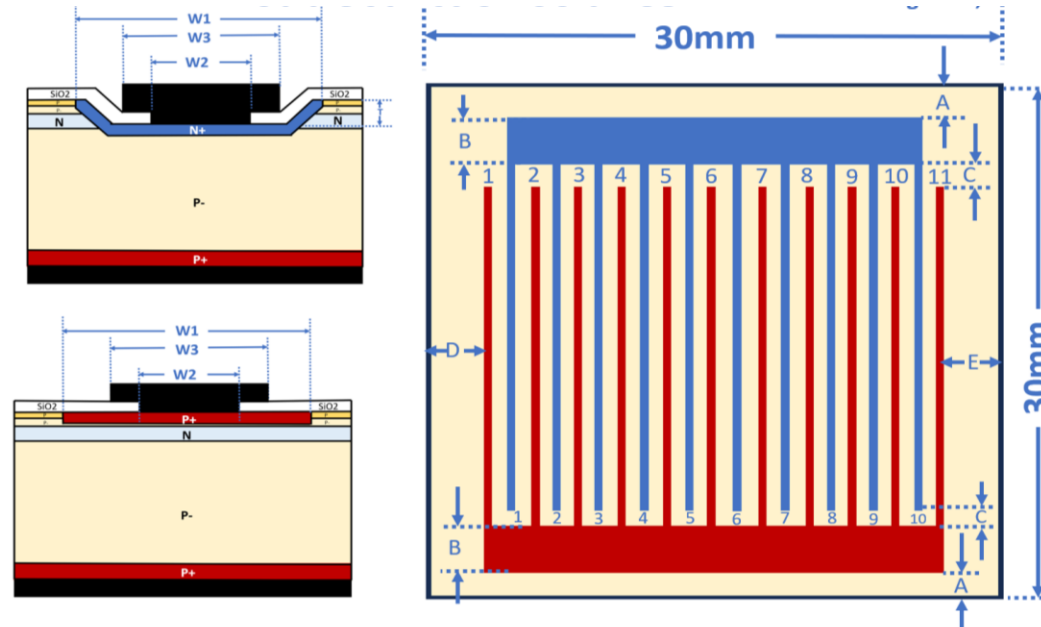
2000	X= 28.0	Y= 0.9	W= 1.0	H= 28.3
2001	X= 3.0	Y= 0.9	W= 25.0	H= 0.3
2002	X= 3.0	Y= 3.7	W= 25.0	H= 0.3
2003	X= 3.0	Y= 6.5	W= 25.0	H= 0.3
2004	X= 3.0	Y= 9.3	W= 25.0	H= 0.3
2005	X= 3.0	Y= 12.1	W= 25.0	H= 0.3
2006	X= 3.0	Y= 14.9	W= 25.0	H= 0.3
2007	X= 3.0	Y= 17.7	W= 25.0	H= 0.3
2008	X= 3.0	Y= 20.5	W= 25.0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

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

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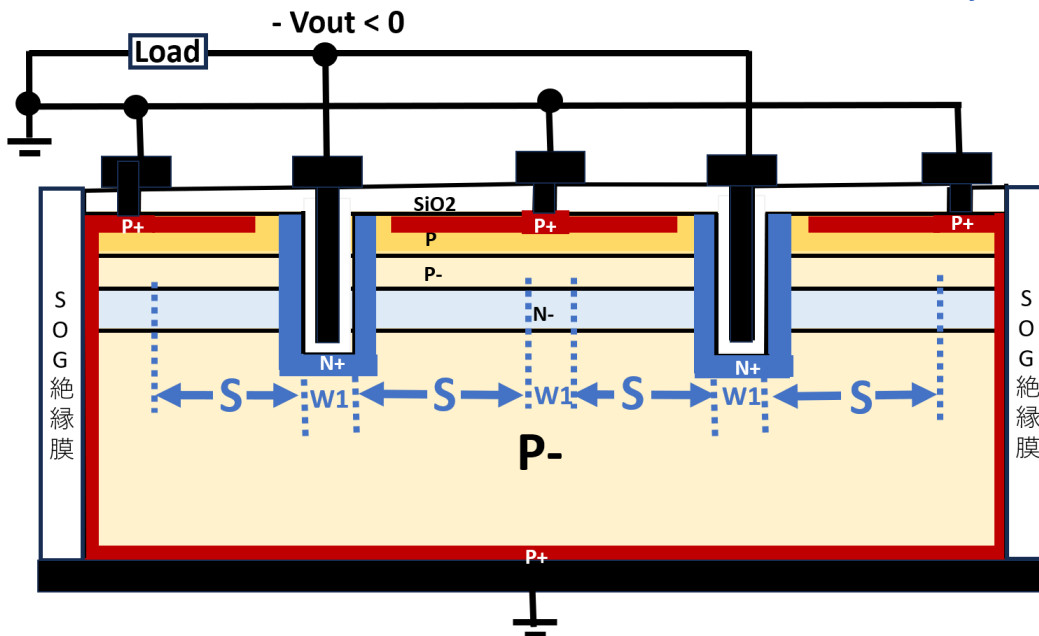
$A=1; B=1; C=1; D=0.9; E=0.8; L=25;$
 $W1=0.3; W2=0.1; W3=0.2; S=1.1;$

MASK02A P+ Diffusion



***** MASK2A *****

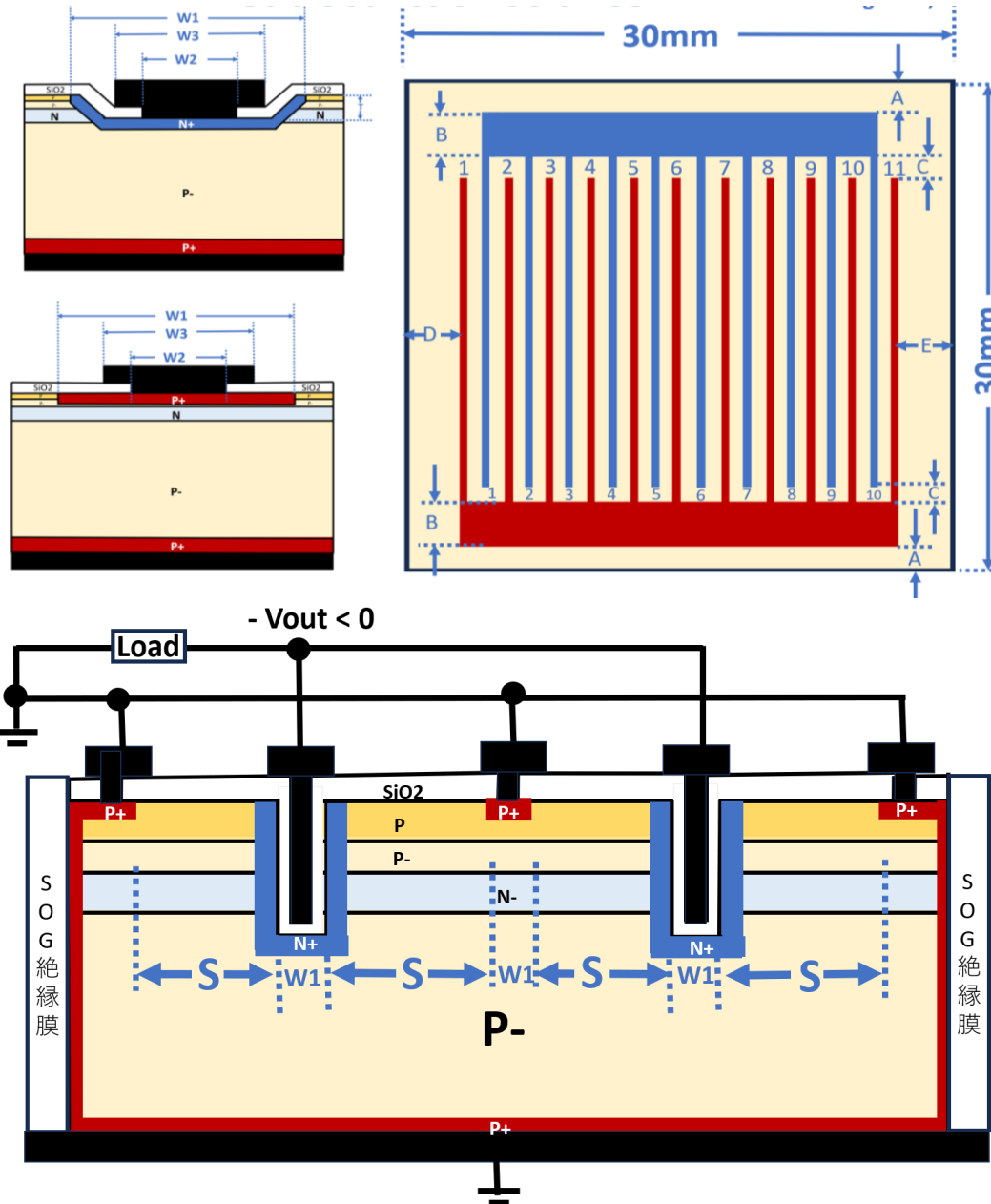
5000	X= 28.0	Y= 0.0	W= 2.0	H= 30.0
5001	X= 0.0	Y= 0.0	W= 28.0	H= 2.2
5002	X= 3.0	Y= 2.7	W= 25.0	H= 2.3
5003	X= 3.0	Y= 5.5	W= 25.0	H= 2.3
5004	X= 3.0	Y= 8.3	W= 25.0	H= 2.3
5005	X= 3.0	Y= 11.1	W= 25.0	H= 2.3
5006	X= 3.0	Y= 13.9	W= 25.0	H= 2.3
5007	X= 3.0	Y= 16.7	W= 25.0	H= 2.3
5008	X= 3.0	Y= 19.5	W= 25.0	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 $W1=0.3$;

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

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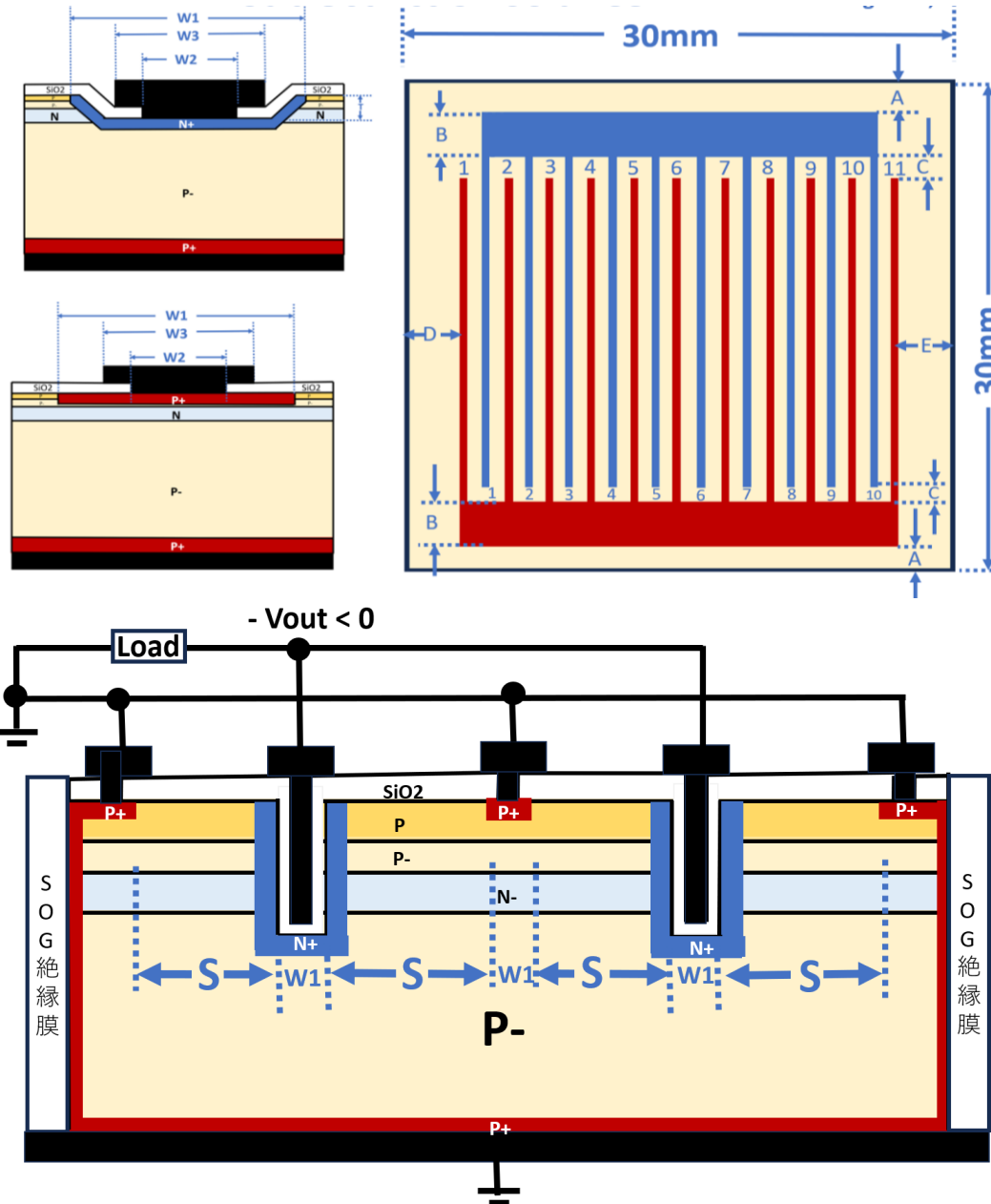
A=1;B=1;C=1;D=0.9;E=0.8;L=25;
W1=0.3;W2=0.1;W3=0.2;S=1.1;

MASK03 Contact Window

***** MASK3 *****				
3000	X= 1.1	Y= 2.4	W= 0.8	H= 25.3
3001	X= 2.1	Y= 2.4	W= 24.8	H= 0.1
3002	X= 2.1	Y= 5.2	W= 24.8	H= 0.1
3003	X= 2.1	Y= 8.0	W= 24.8	H= 0.1
3004	X= 2.1	Y= 10.8	W= 24.8	H= 0.1
3005	X= 2.1	Y= 13.6	W= 24.8	H= 0.1
3006	X= 2.1	Y= 16.4	W= 24.8	H= 0.1
3007	X= 2.1	Y= 19.2	W= 24.8	H= 0.1
3008	X= 2.1	Y= 22.0	W= 24.8	H= 0.1
3009	X= 2.1	Y= 24.8	W= 24.8	H= 0.1
3010	X= 2.1	Y= 27.6	W= 24.8	H= 0.1
3100	X= 28.1	Y= 1.0	W= 0.8	H= 28.1
3101	X= 3.1	Y= 1.0	W= 24.8	H= 0.1
3102	X= 3.1	Y= 3.8	W= 24.8	H= 0.1
3103	X= 3.1	Y= 6.6	W= 24.8	H= 0.1
3104	X= 3.1	Y= 9.4	W= 24.8	H= 0.1
3105	X= 3.1	Y= 12.2	W= 24.8	H= 0.1
3106	X= 3.1	Y= 15.0	W= 24.8	H= 0.1
3107	X= 3.1	Y= 17.8	W= 24.8	H= 0.1
3108	X= 3.1	Y= 20.6	W= 24.8	H= 0.1
3109	X= 3.1	Y= 23.4	W= 24.8	H= 0.1
3110	X= 3.1	Y= 26.2	W= 24.8	H= 0.1
3111	X= 3.1	Y= 29.0	W= 24.8	H= 0.1

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

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

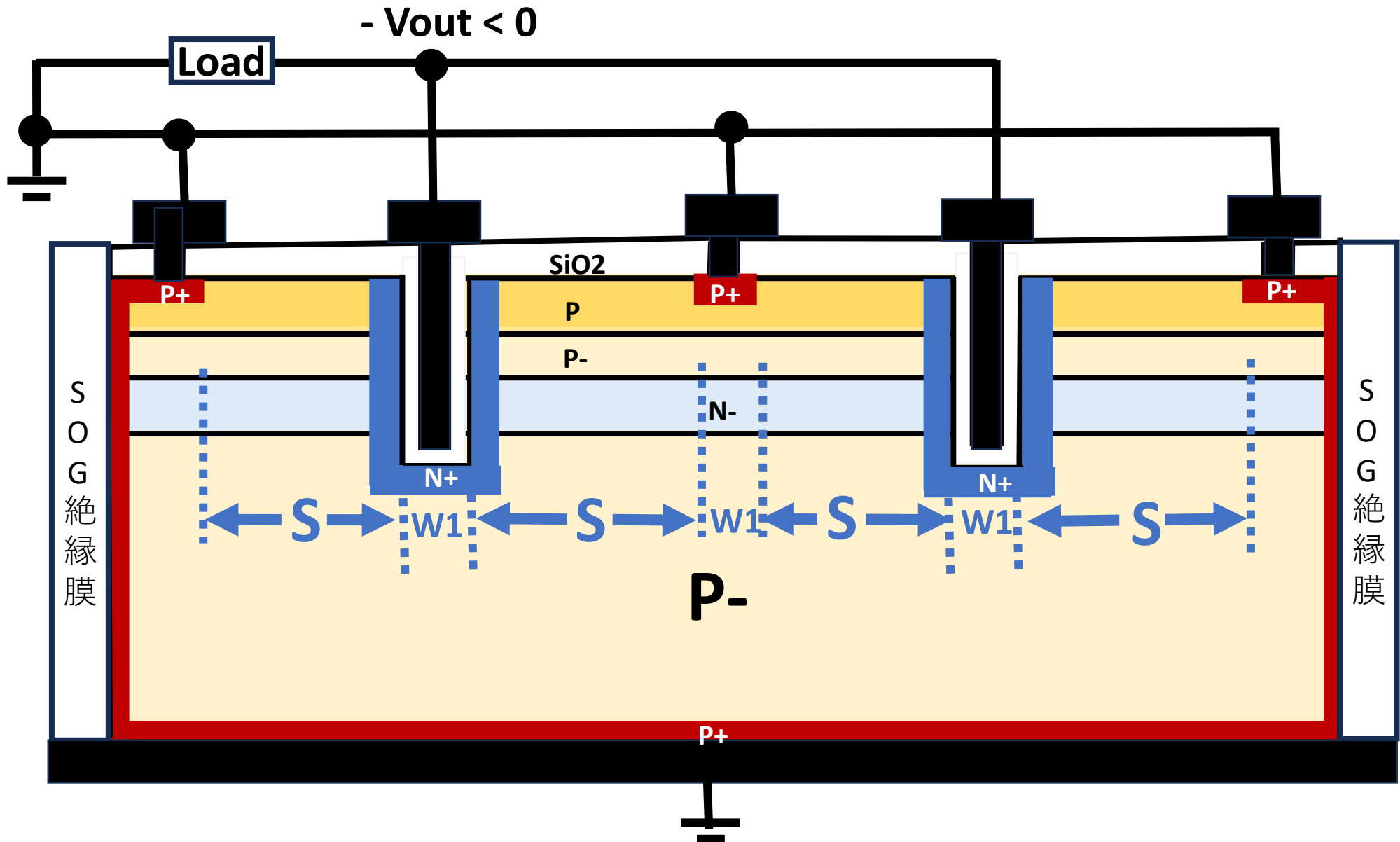
MASK04 Metal Wiring

***** MASK4 *****

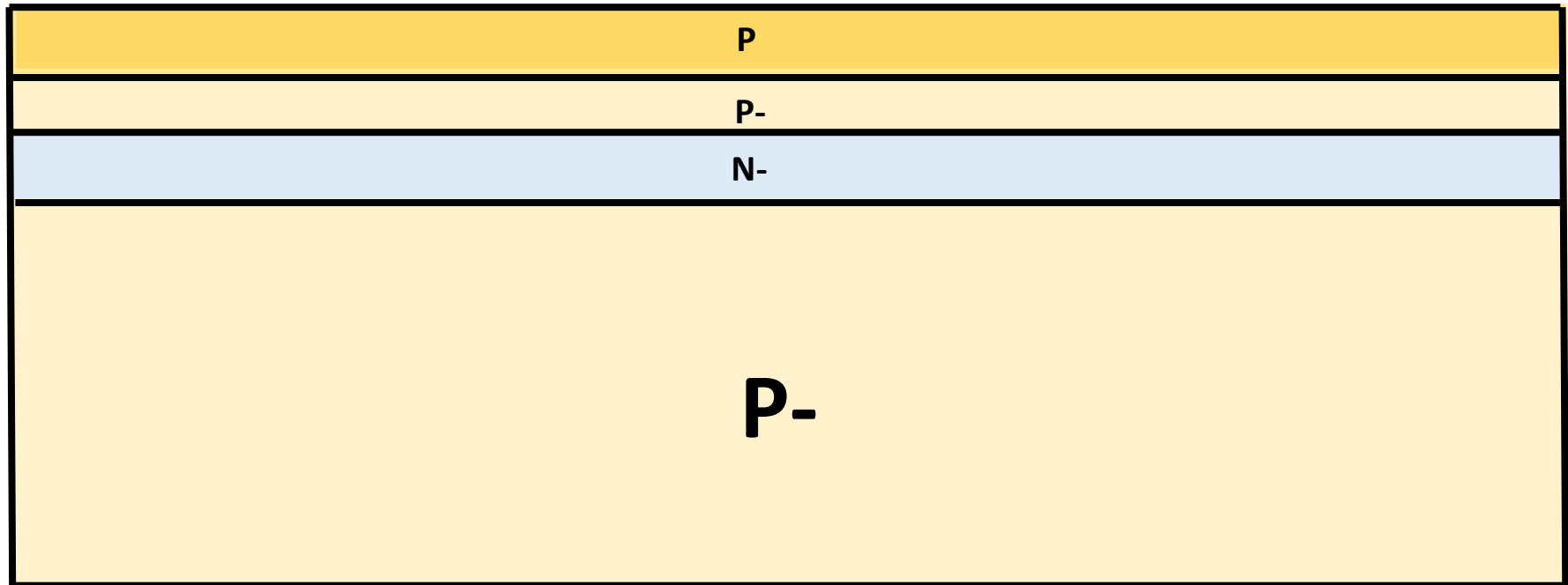
4000	X=	1.05	Y=	2.35	W=	0.9	H=	25.4
4001	X=	2.05	Y=	2.35	W=	24.9	H=	0.2
4002	X=	2.05	Y=	5.15	W=	24.9	H=	0.2
4003	X=	2.05	Y=	7.95	W=	24.9	H=	0.2
4004	X=	2.05	Y=	10.75	W=	24.9	H=	0.2
4005	X=	2.05	Y=	13.55	W=	24.9	H=	0.2
4006	X=	2.05	Y=	16.35	W=	24.9	H=	0.2
4007	X=	2.05	Y=	19.15	W=	24.9	H=	0.2
4008	X=	2.05	Y=	21.95	W=	24.9	H=	0.2
4009	X=	2.05	Y=	24.75	W=	24.9	H=	0.2
4010	X=	2.05	Y=	27.55	W=	24.9	H=	0.2
4100	X=	28.05	Y=	0.95	W=	0.9	H=	28.2
4101	X=	3.05	Y=	0.95	W=	24.9	H=	0.2
4102	X=	3.05	Y=	3.75	W=	24.9	H=	0.2
4103	X=	3.05	Y=	6.55	W=	24.9	H=	0.2
4104	X=	3.05	Y=	9.35	W=	24.9	H=	0.2
4105	X=	3.05	Y=	12.15	W=	24.9	H=	0.2
4106	X=	3.05	Y=	14.95	W=	24.9	H=	0.2
4107	X=	3.05	Y=	17.75	W=	24.9	H=	0.2
4108	X=	3.05	Y=	20.55	W=	24.9	H=	0.2
4109	X=	3.05	Y=	23.35	W=	24.9	H=	0.2
4110	X=	3.05	Y=	26.15	W=	24.9	H=	0.2
4111	X=	3.05	Y=	28.95	W=	24.9	H=	0.2

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

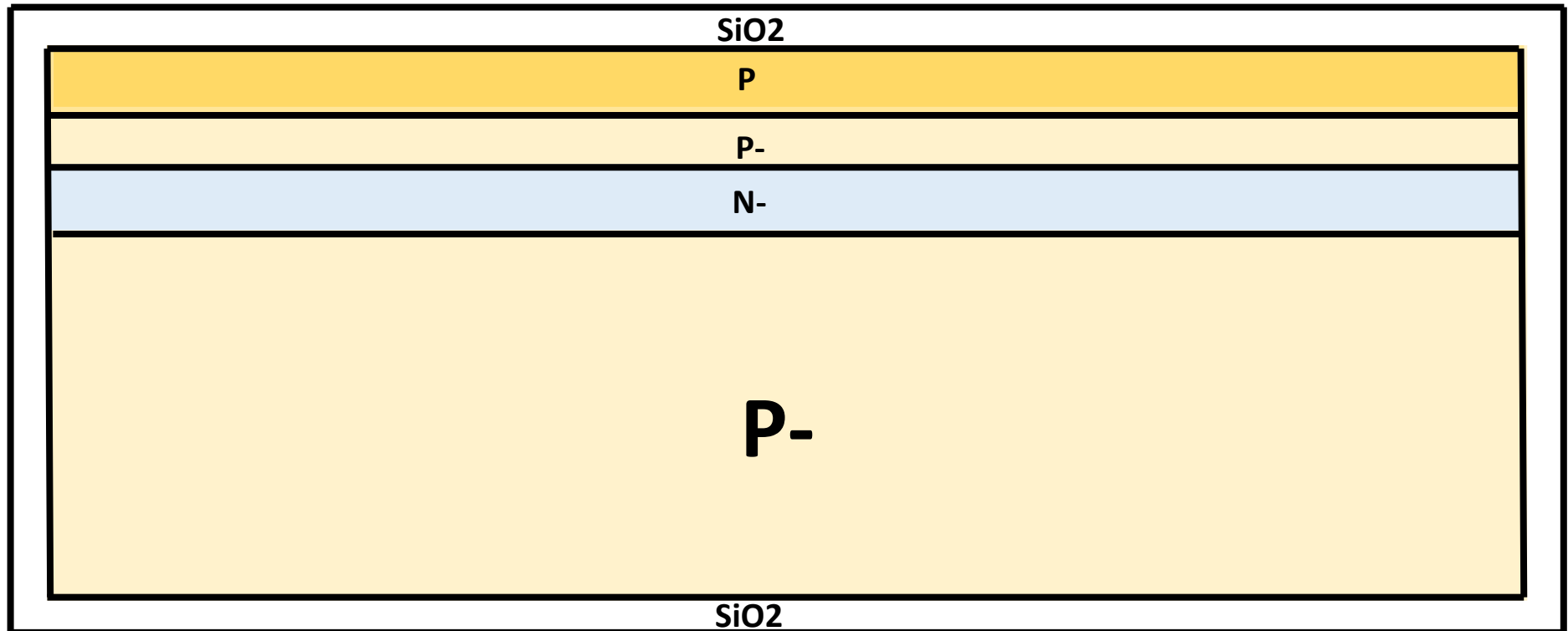
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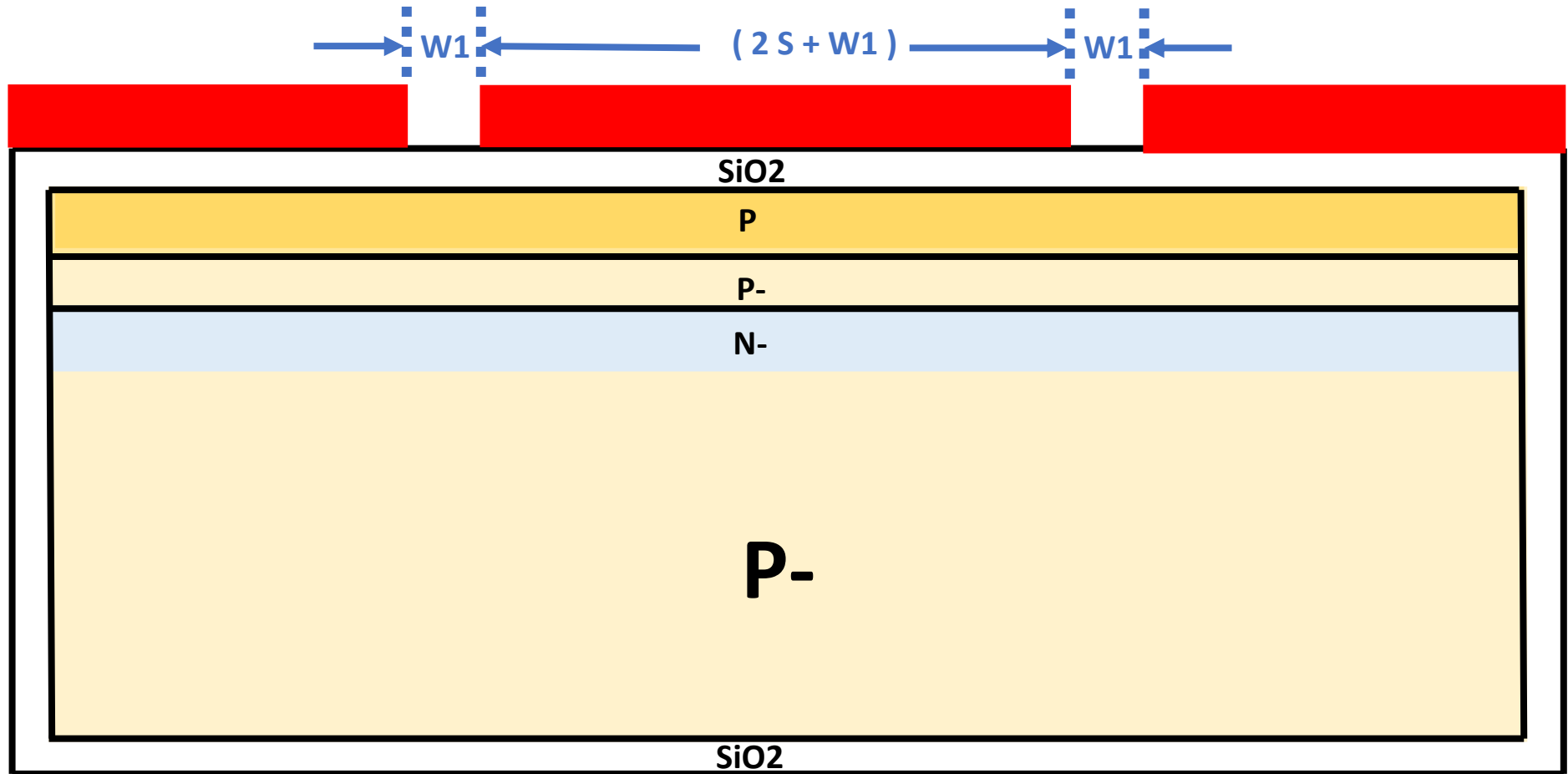
P01 Cleaning Silicon Wafer



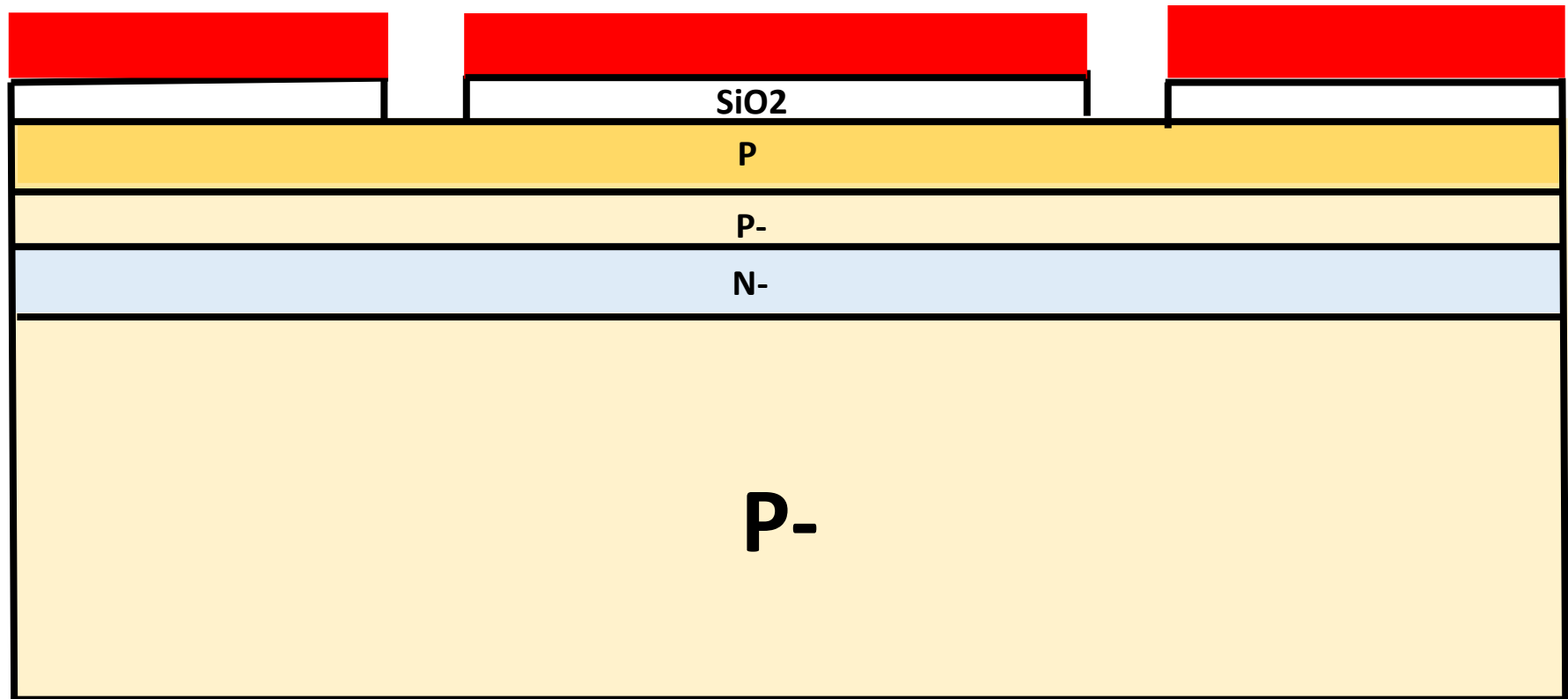
P02 First Oxidation



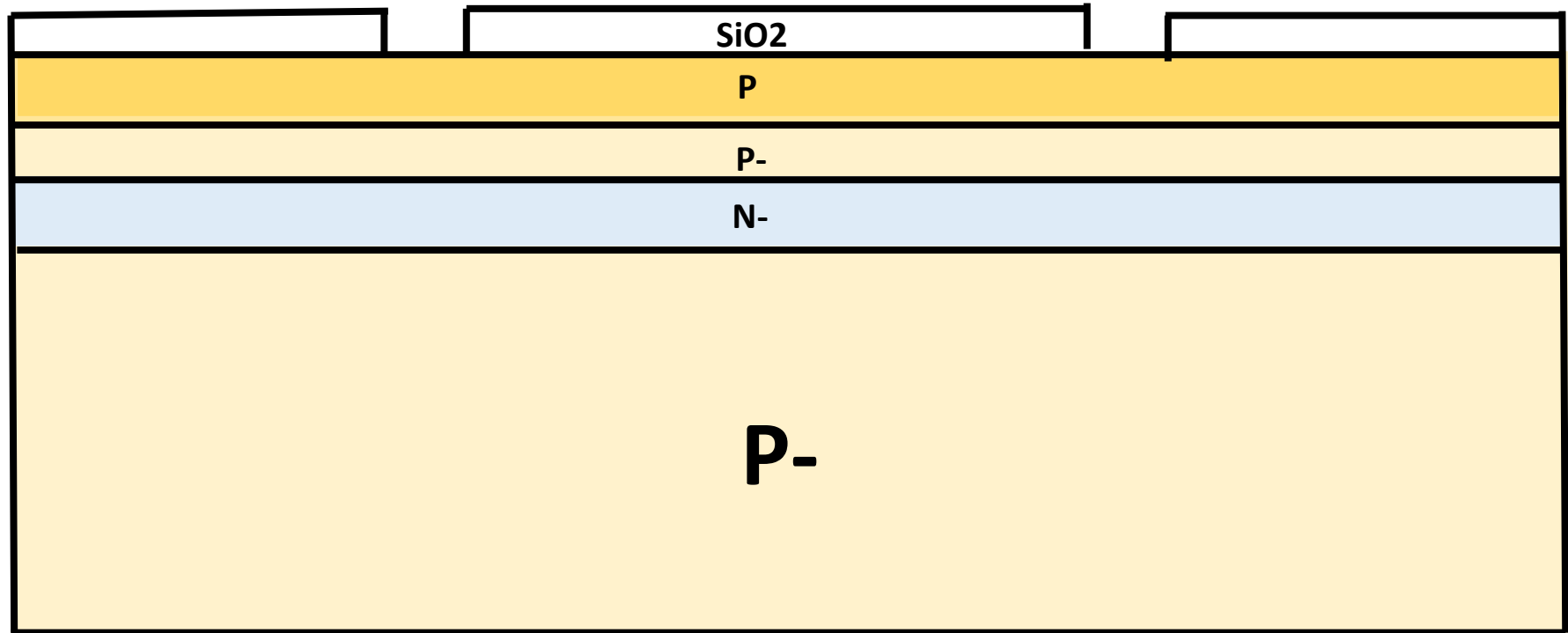
P03 Mask 01 First Resist Coating and Patterning



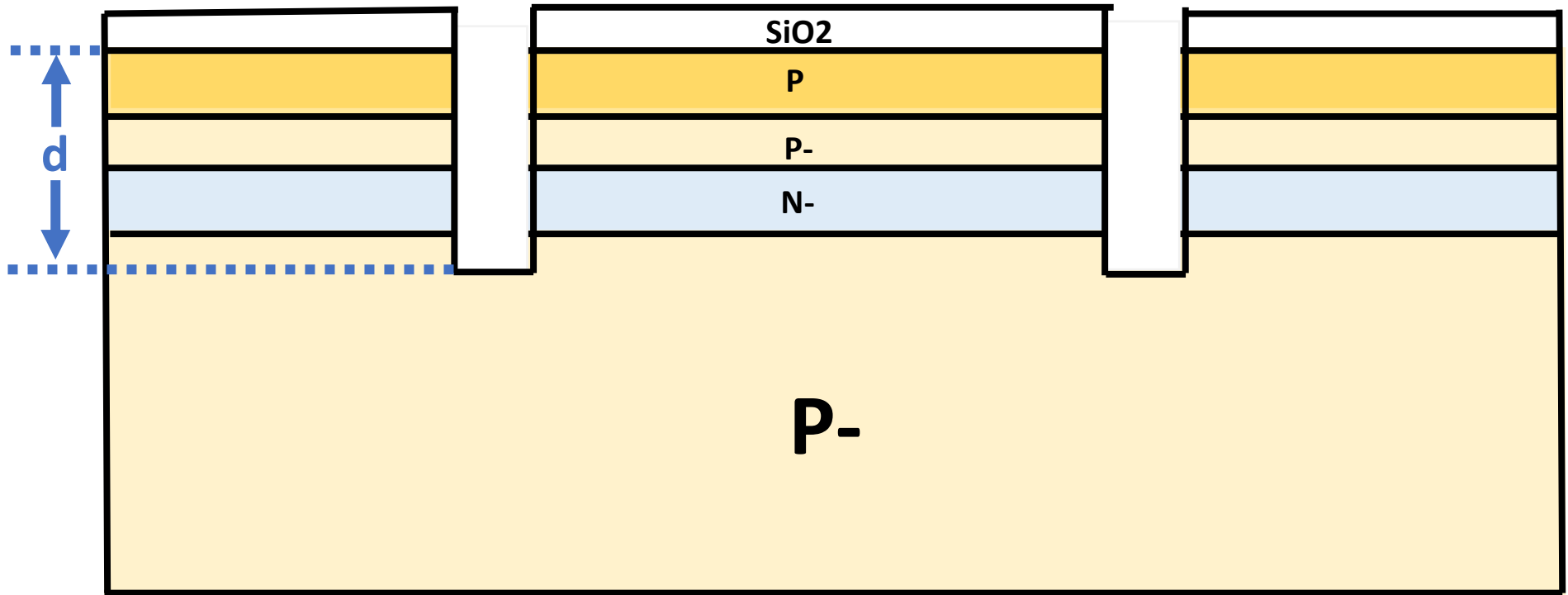
P04 First SiO₂ Etching



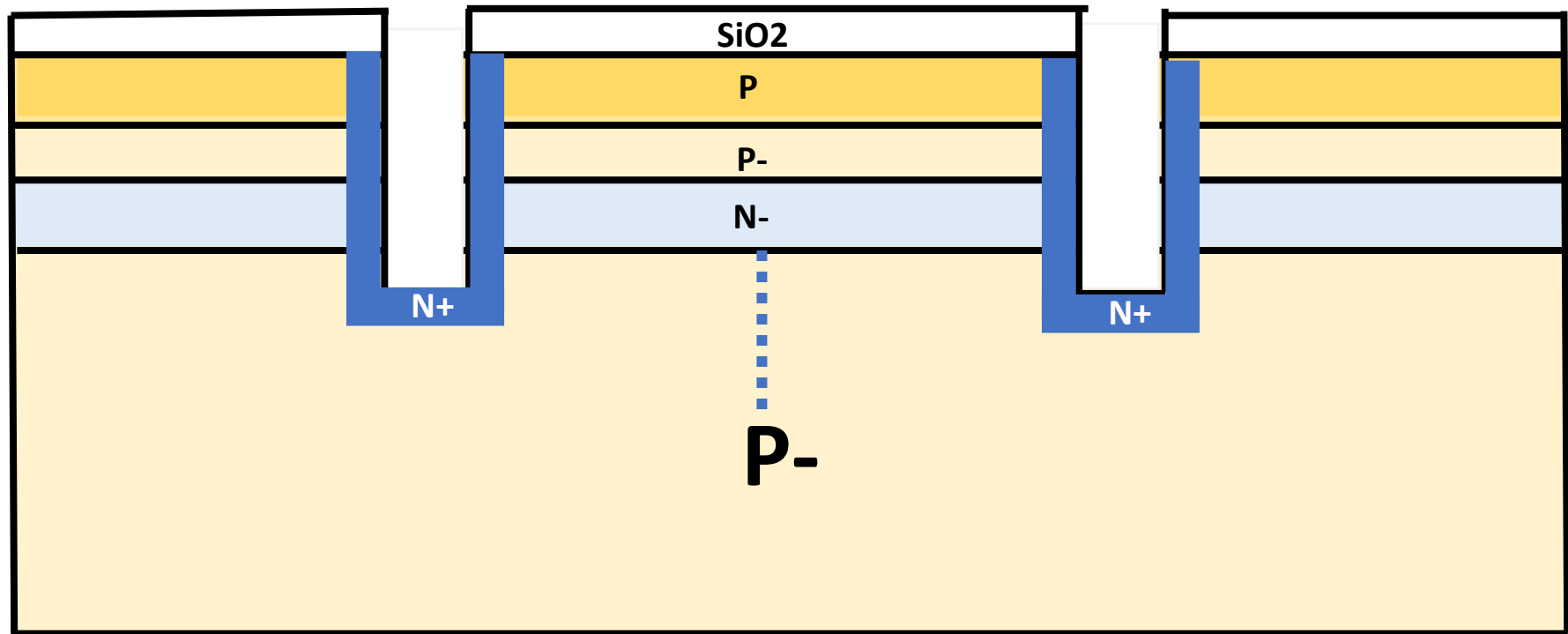
P05 Remove Resist



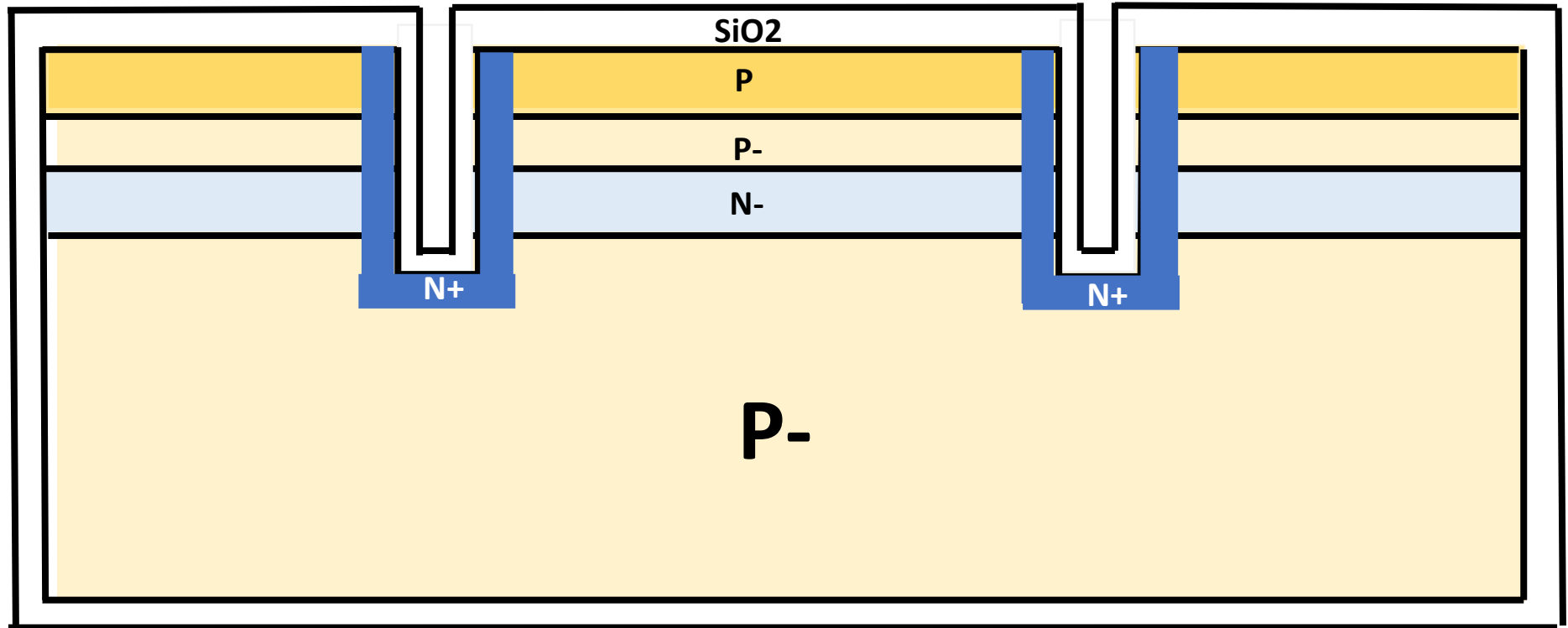
P06 Silicon KOH Etching



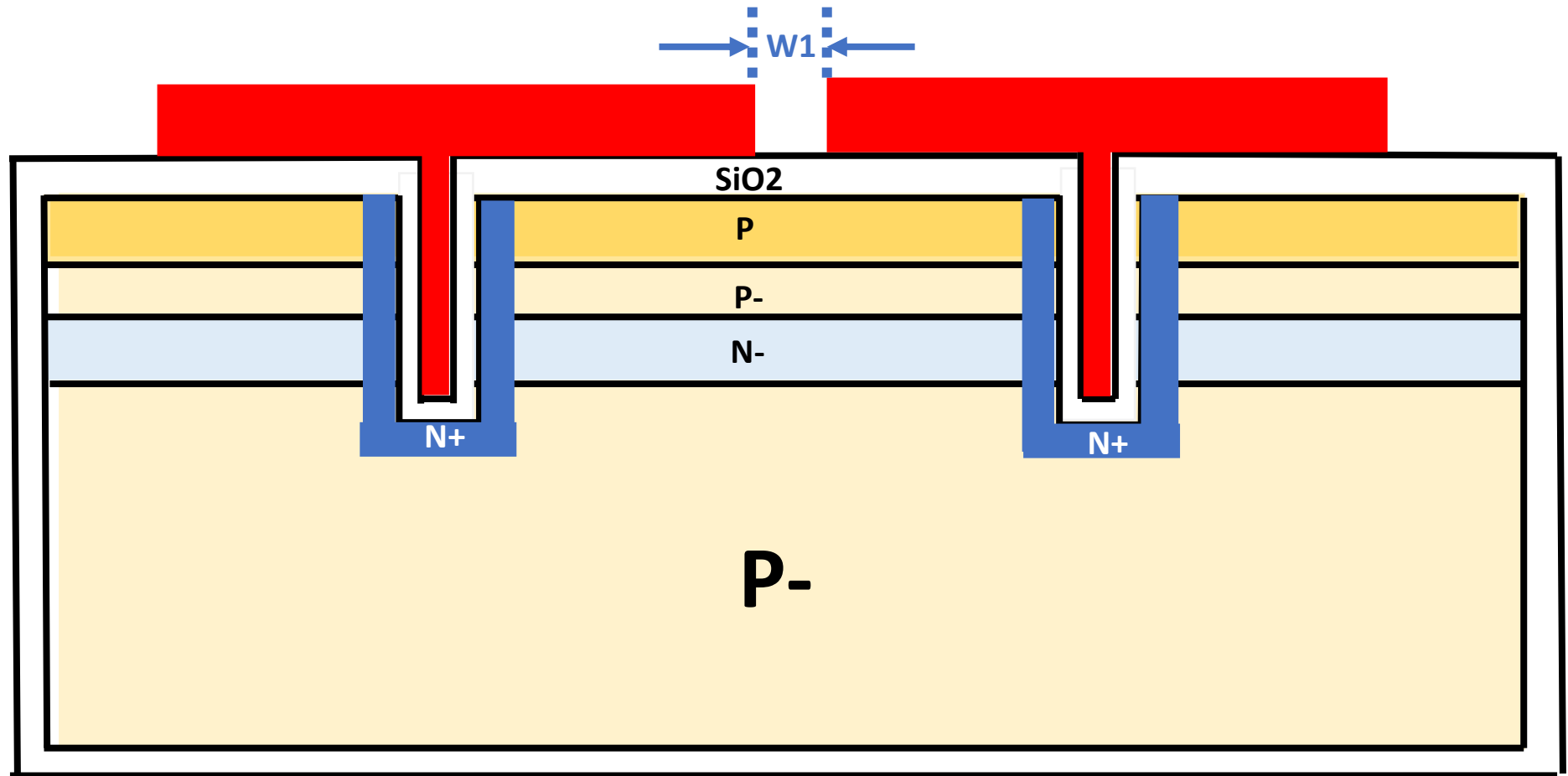
P07 OCD Coating and Thermal N+ Diffusion



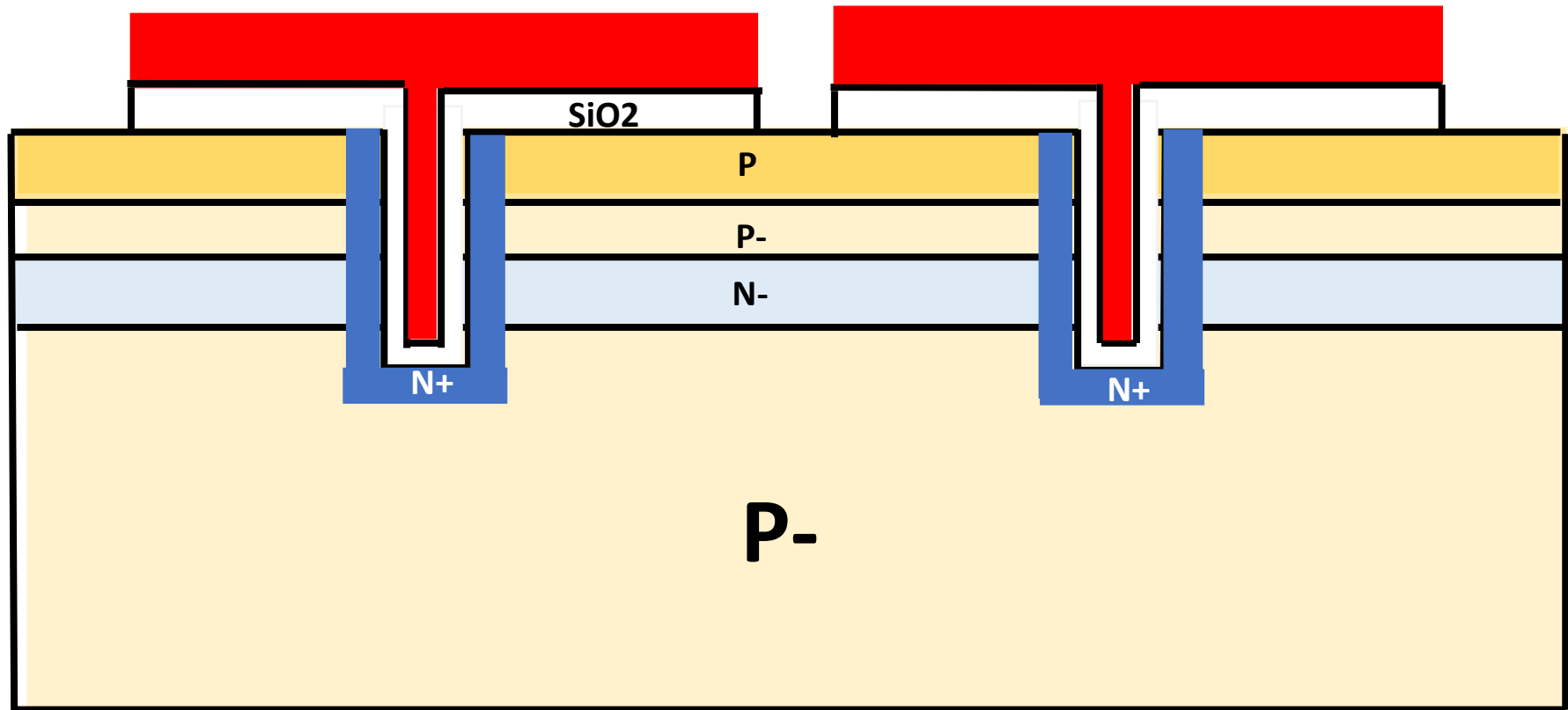
P08 Remove SiO₂ and Second Oxidation



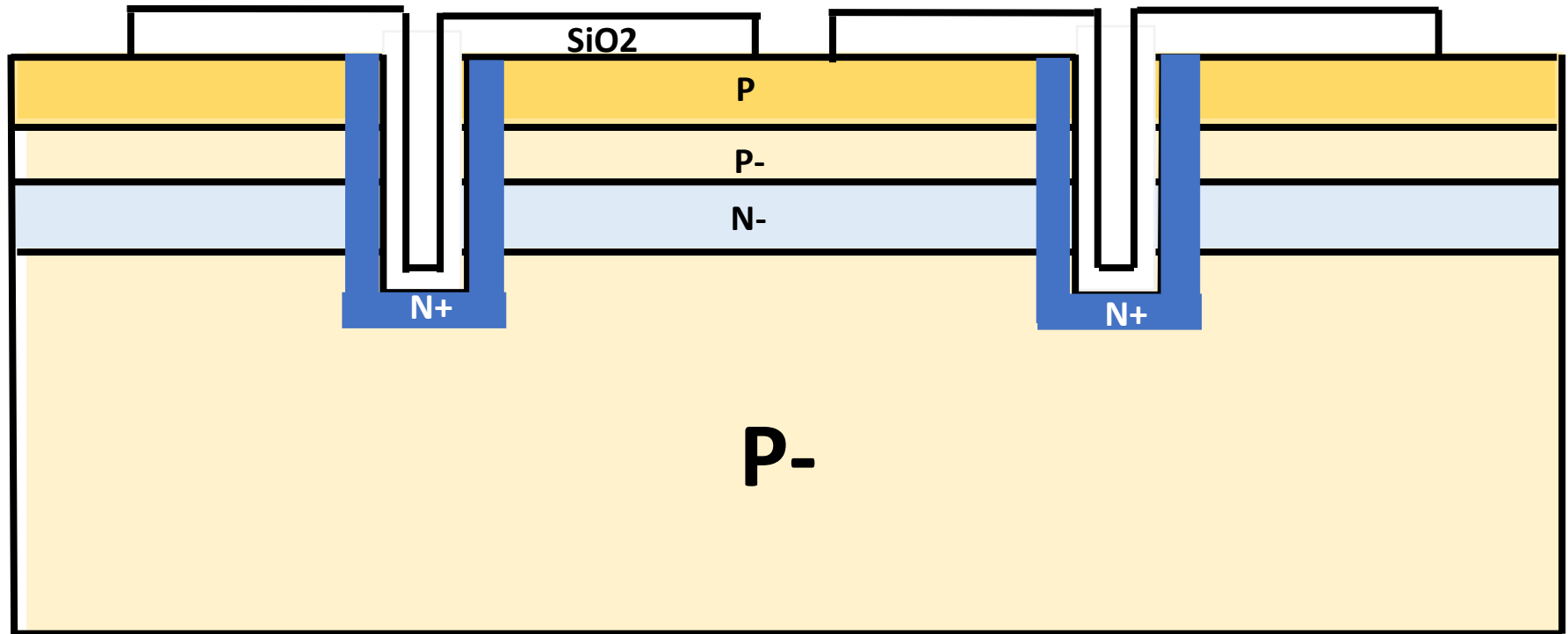
P09 Mask 02 Second Resist Coating and Patterning



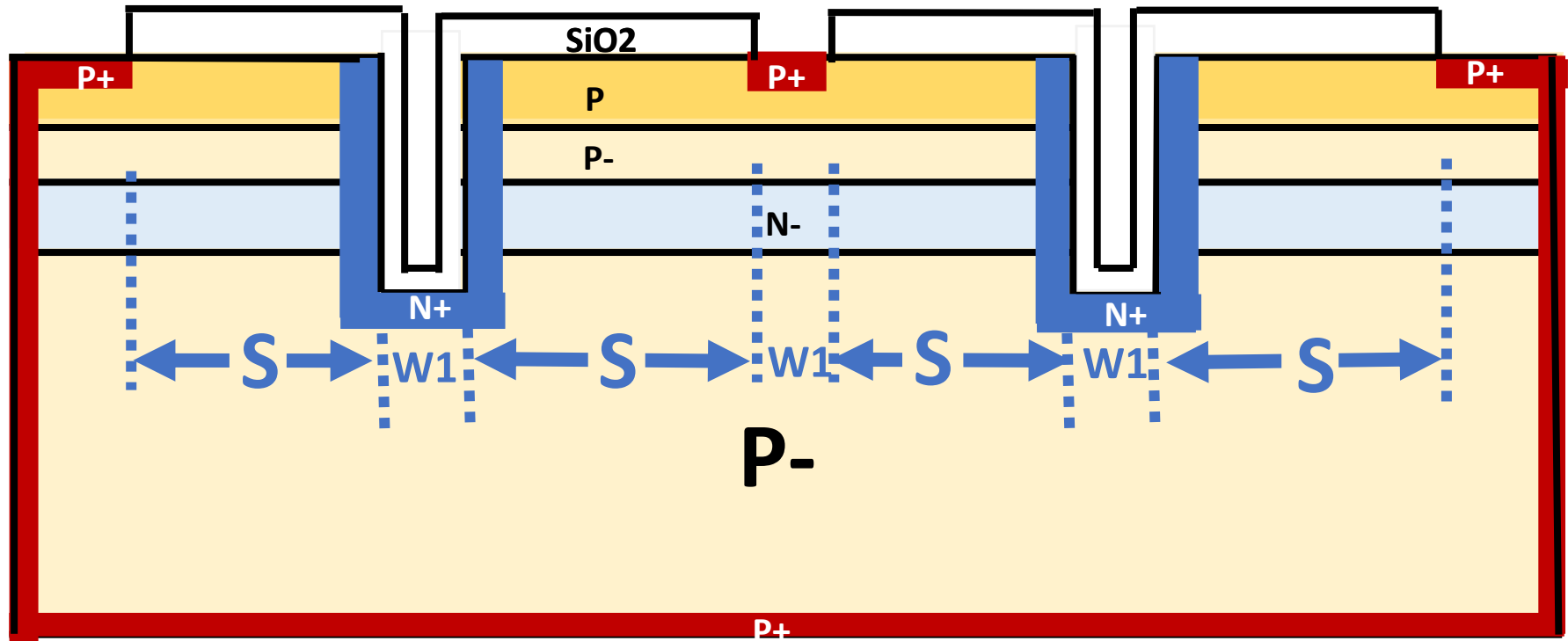
P10 Second SiO₂ Etching



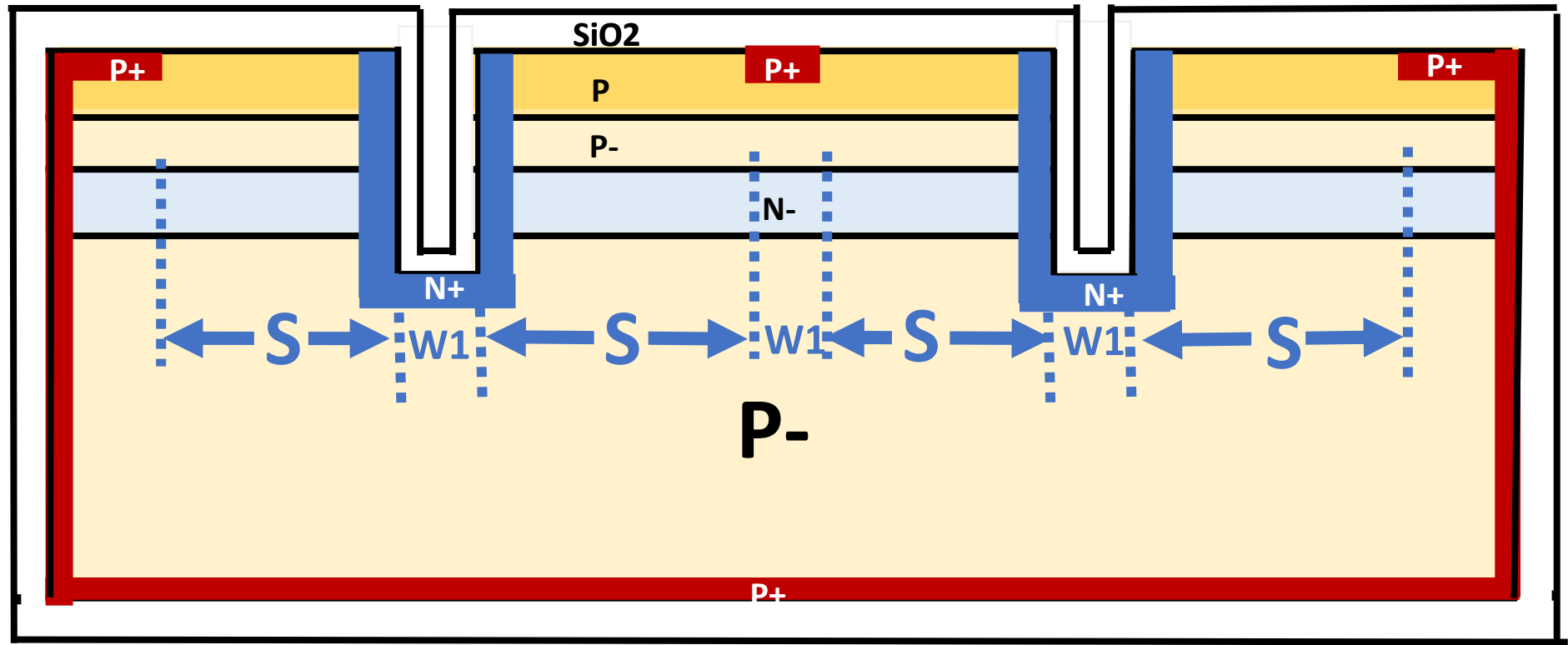
P11 Remove Resist



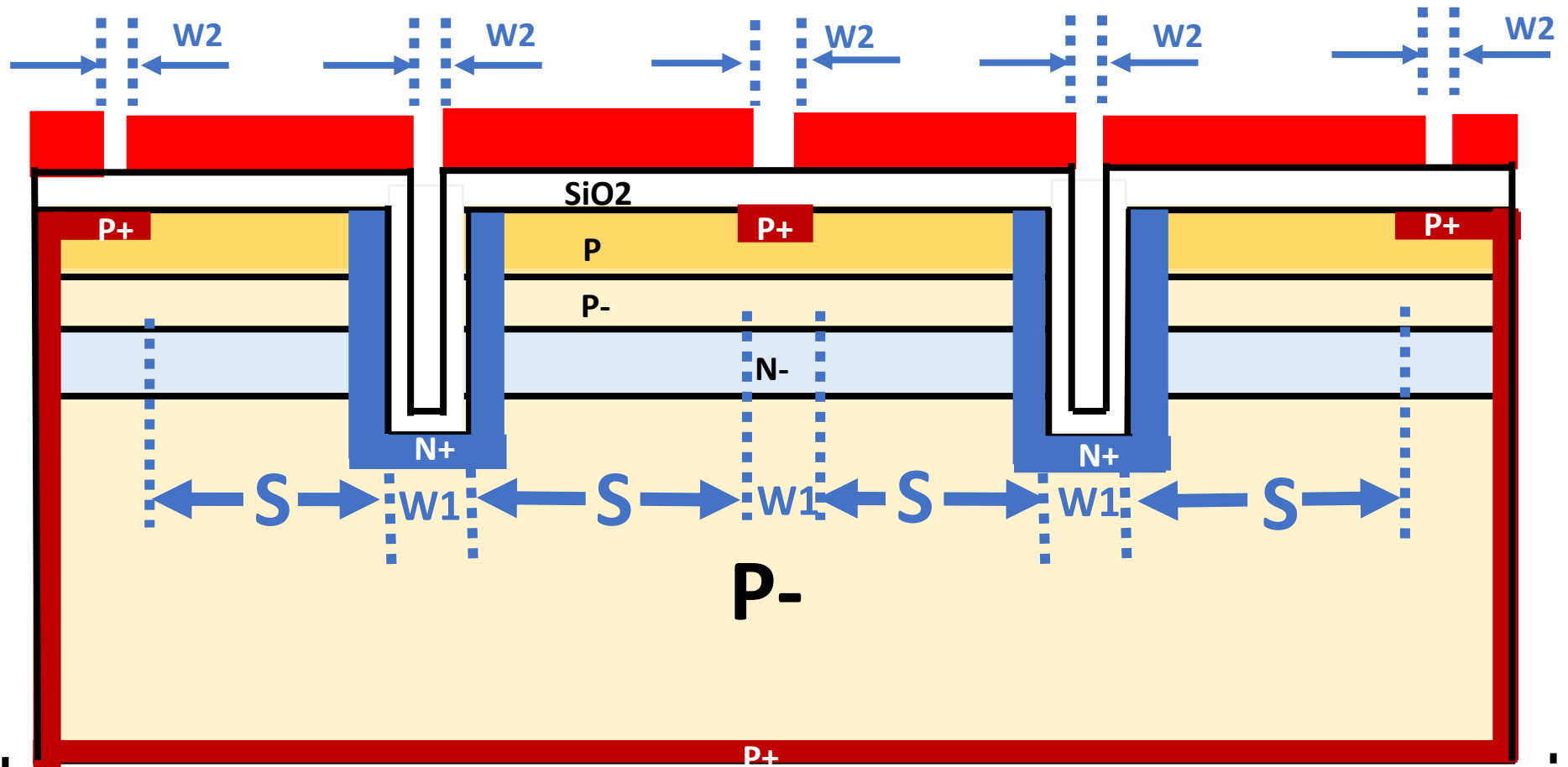
P12 PBF Coating and P+ Diffusion



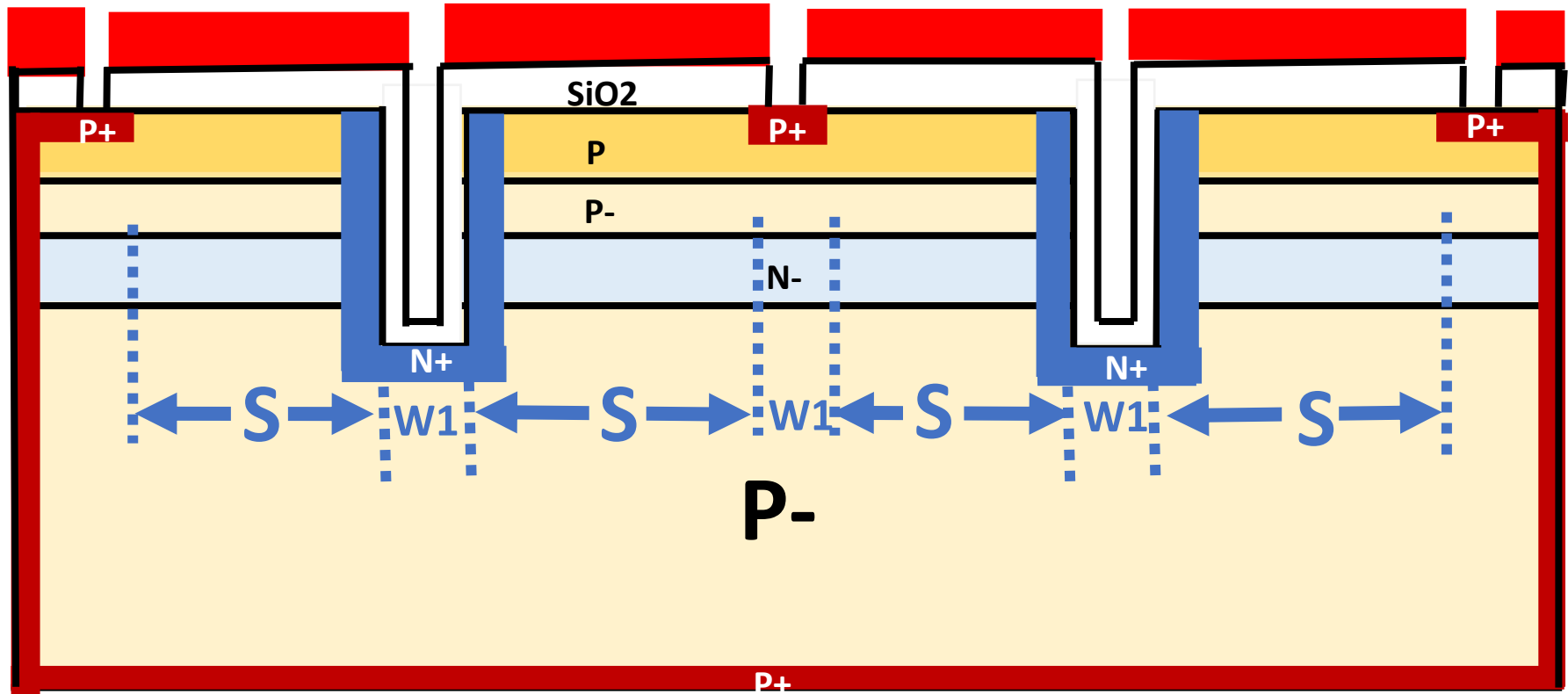
P13 Remove SiO₂ and Third Oxidation



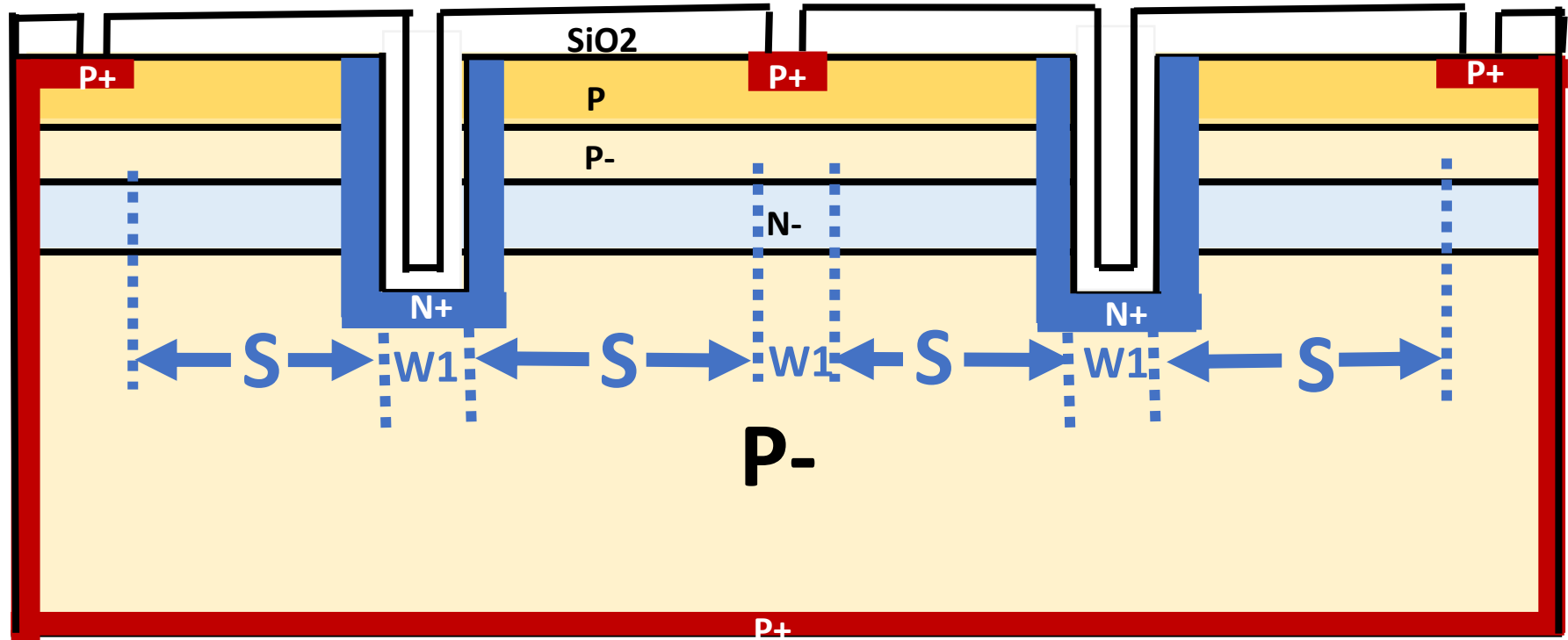
P14 Mask03 Third Resist Coating and Patterning



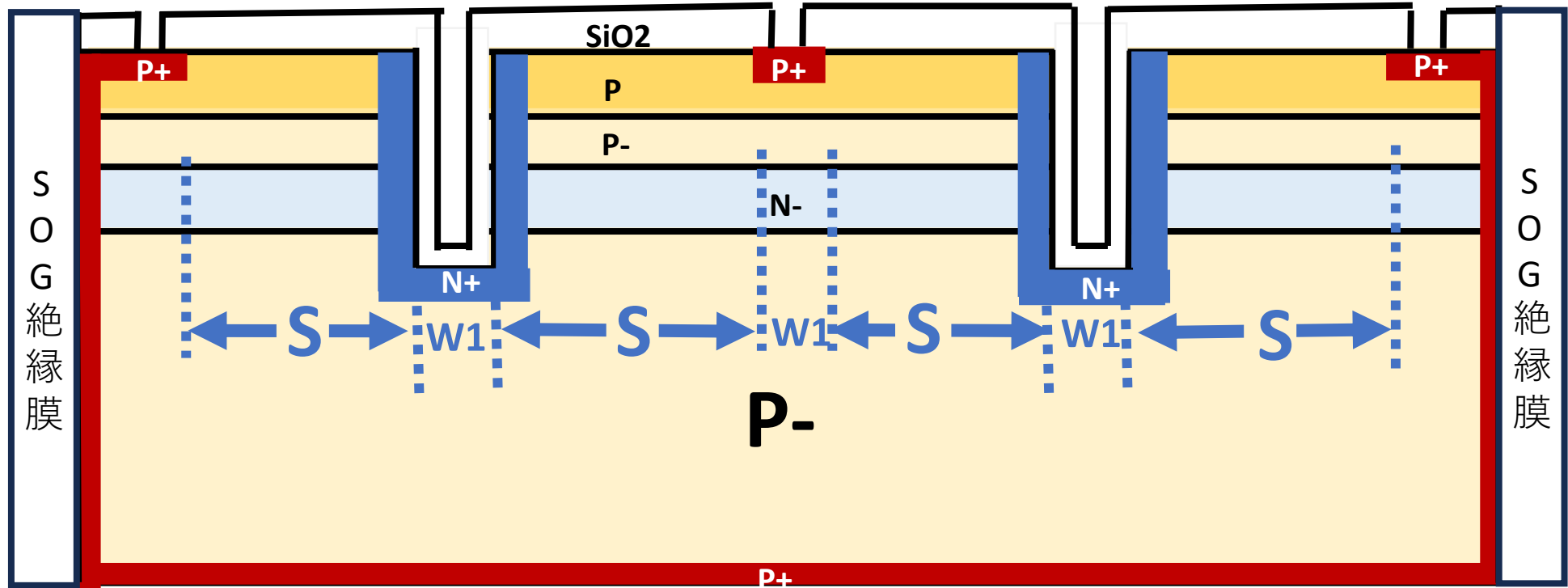
P15 SiO₂ Etching



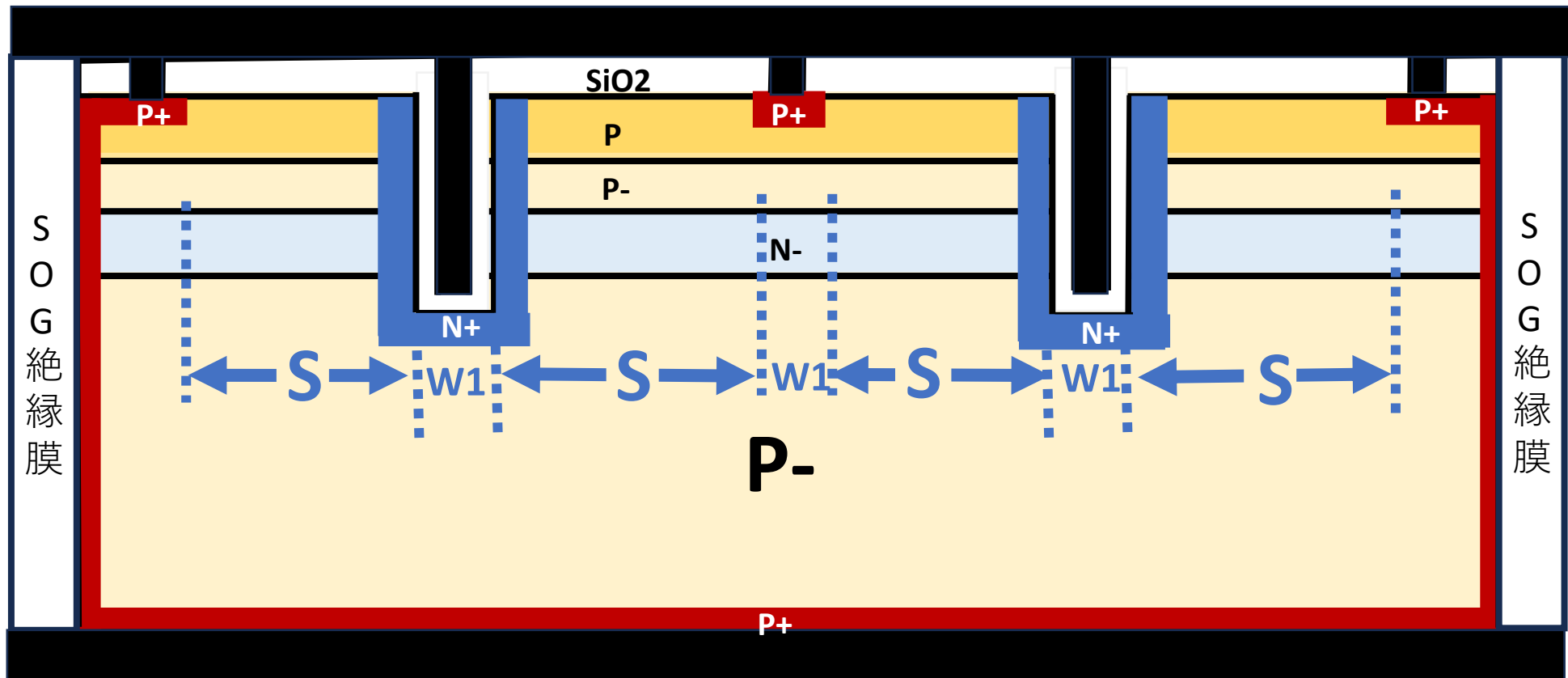
P16 Remove Resist



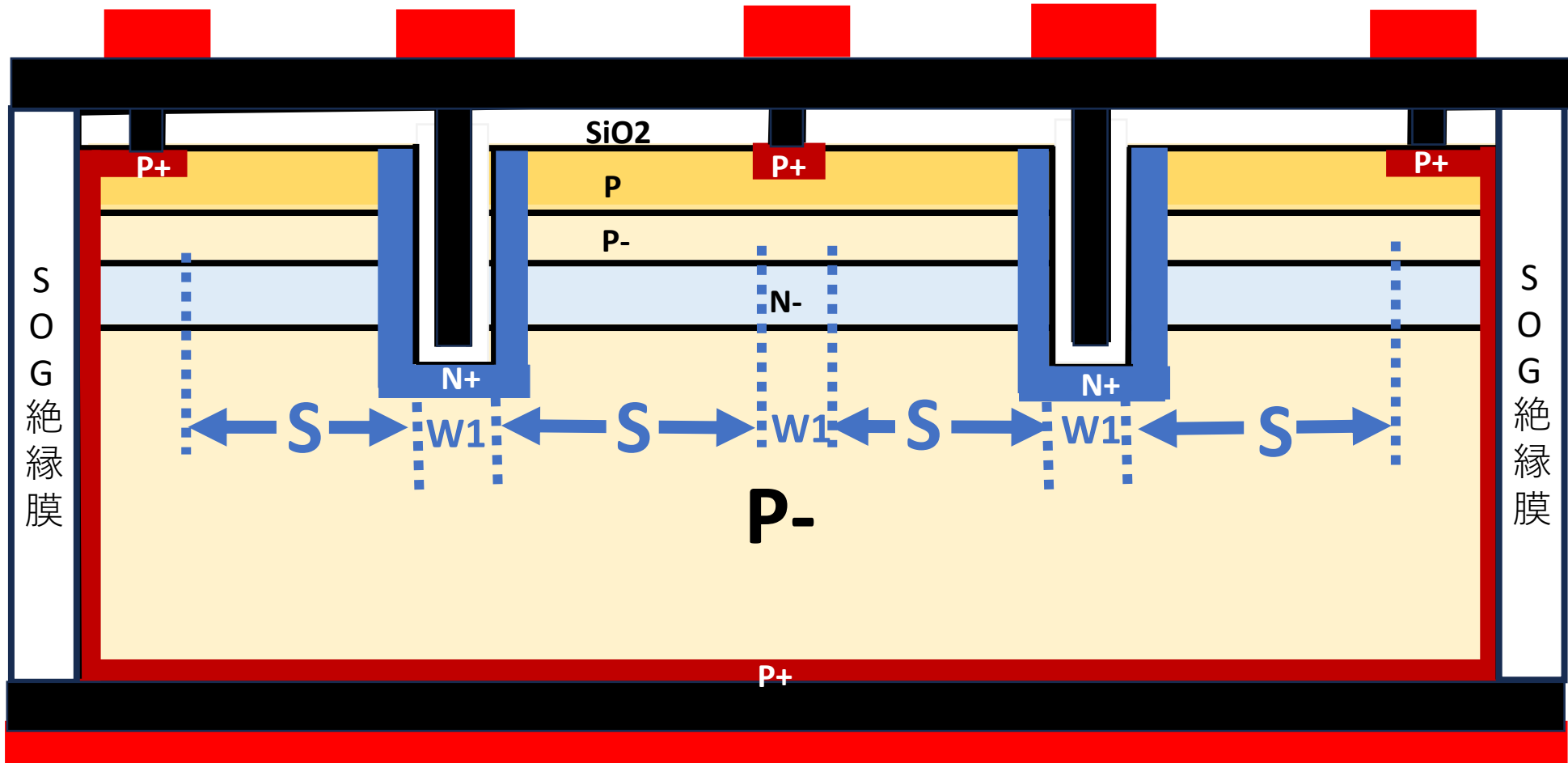
P17 SOG Side Coating



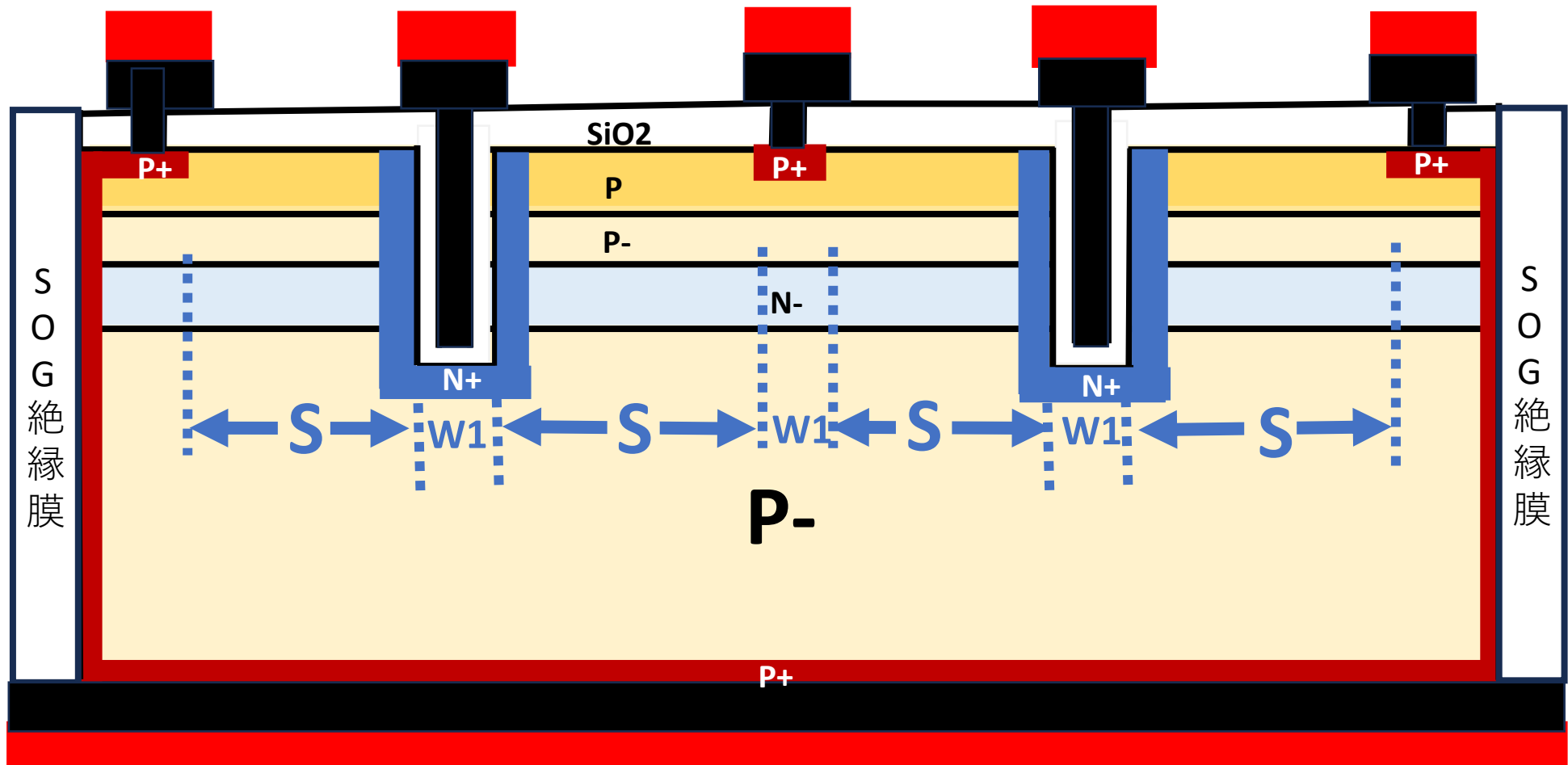
P18 Metal Deposit



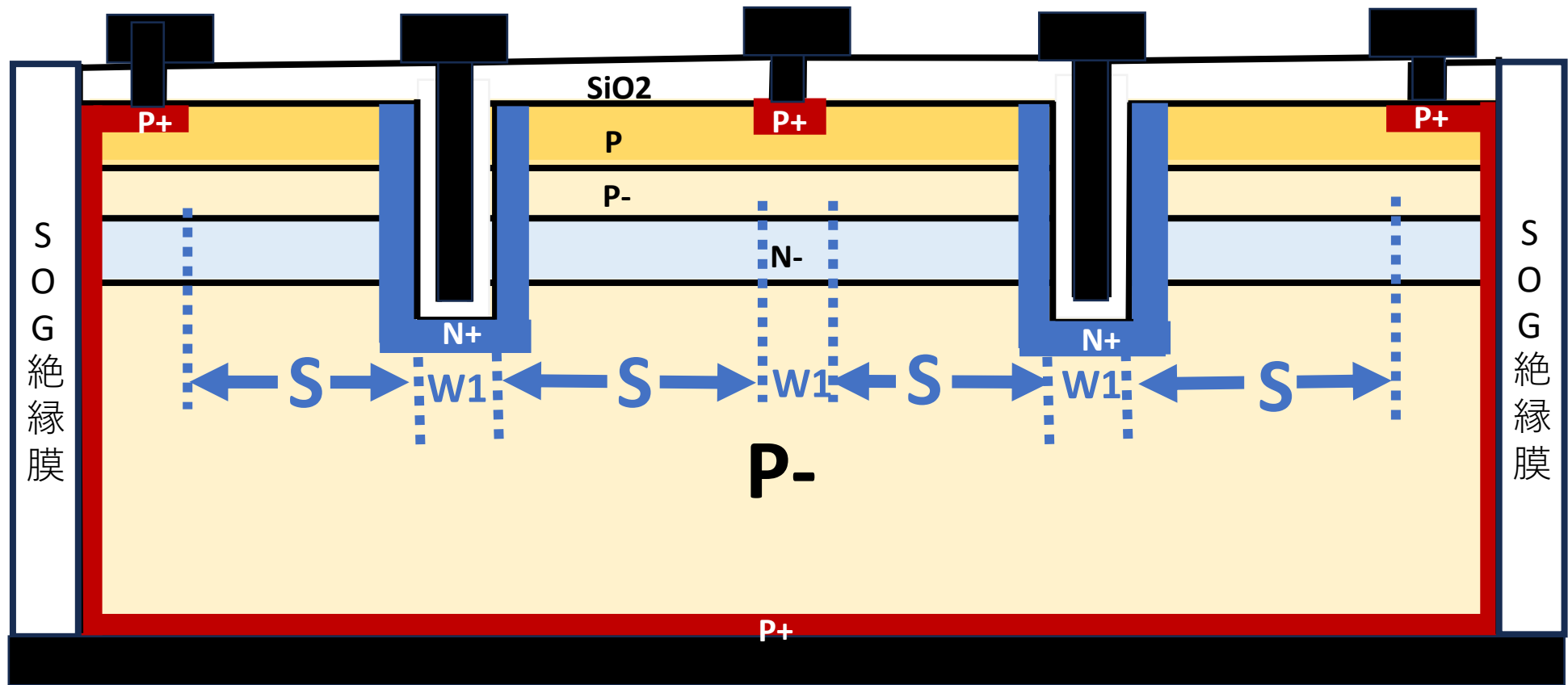
P19 MASK04 Resist Coating and Patterning



P20 Metal Etching



P21 Remove Resist



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

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