

SiC PIN to UCSC measurement results

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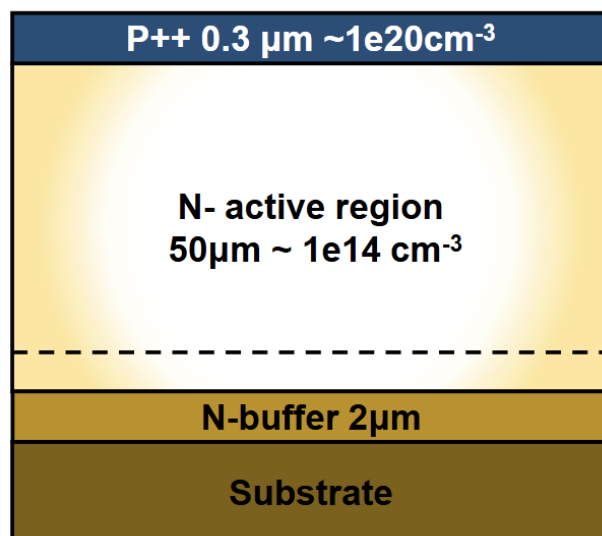
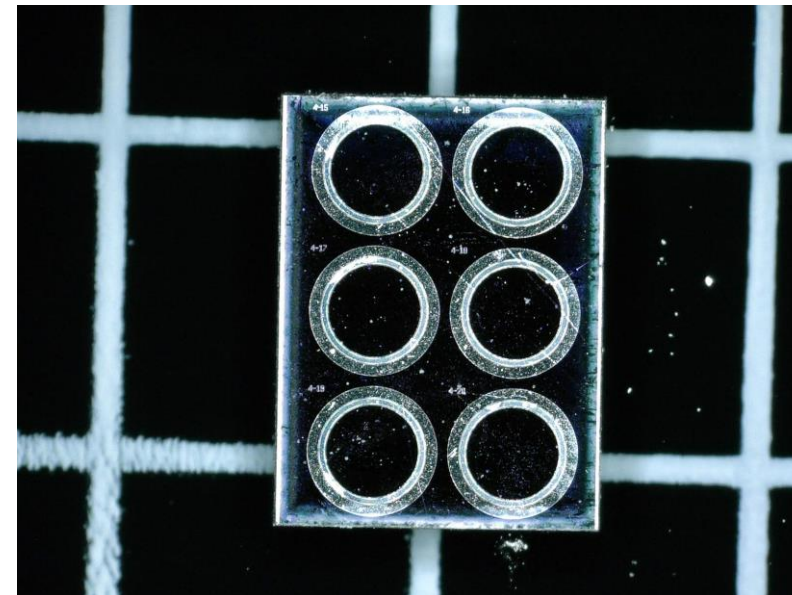
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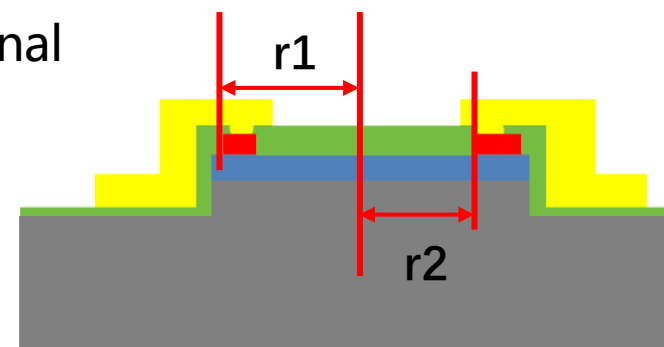
Sample structure and visual check

- use epitaxy, can not add p-stop, so can not build guard ring
- 4-X series Ring size $r1=490\ \mu\text{m}$ $r2=440\ \mu\text{m}$
- annealing temperature = $950\ ^\circ\text{C}$



■ P++ layer ■ N- layer ■ electrode ■ passivation layer ■ metal layer

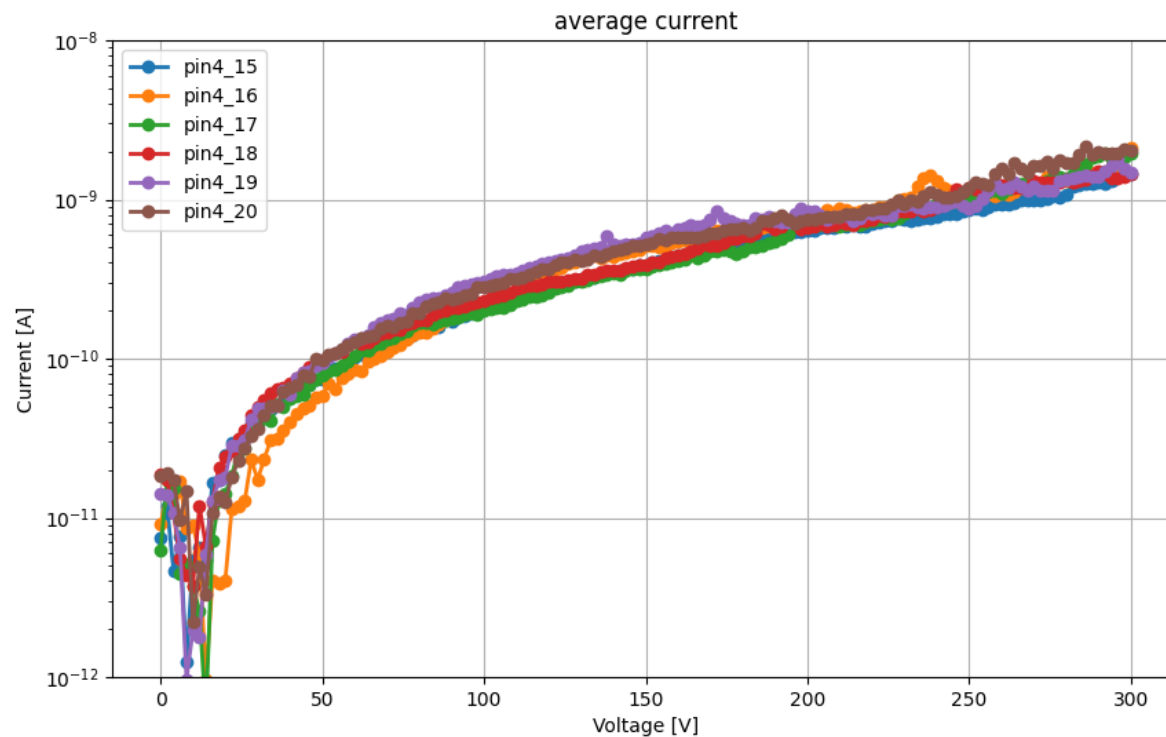
Sectional View:



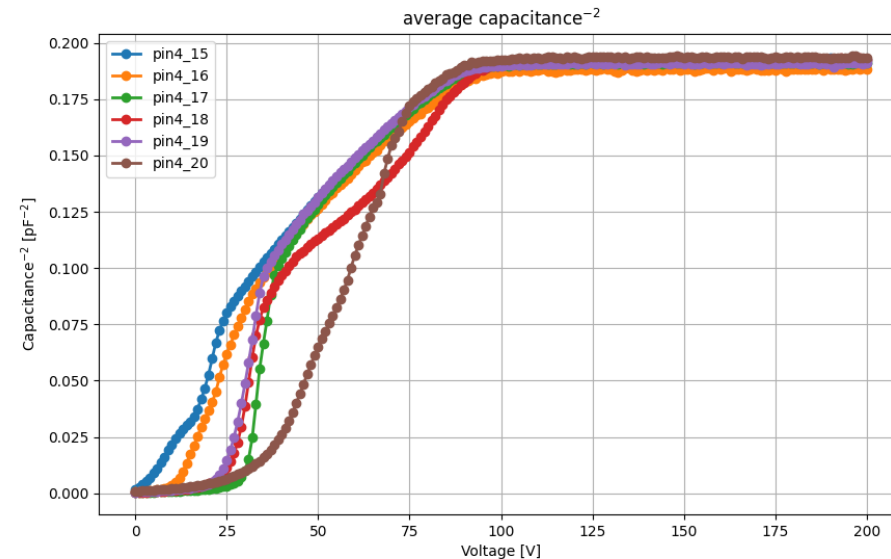
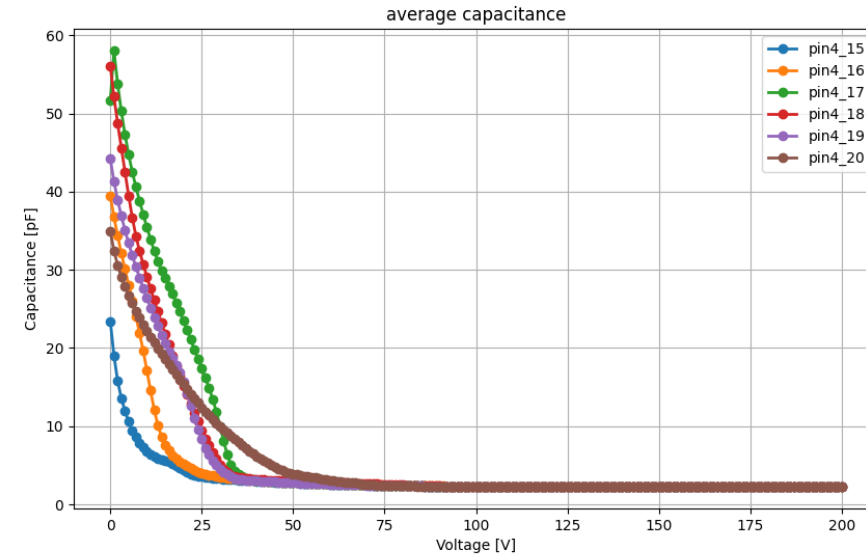
Ring electrode



- Temperature = 22°C
- No precise humidity control (clean room RH<44%)
- Each point measure 5 times and get average value
- Have good consistency



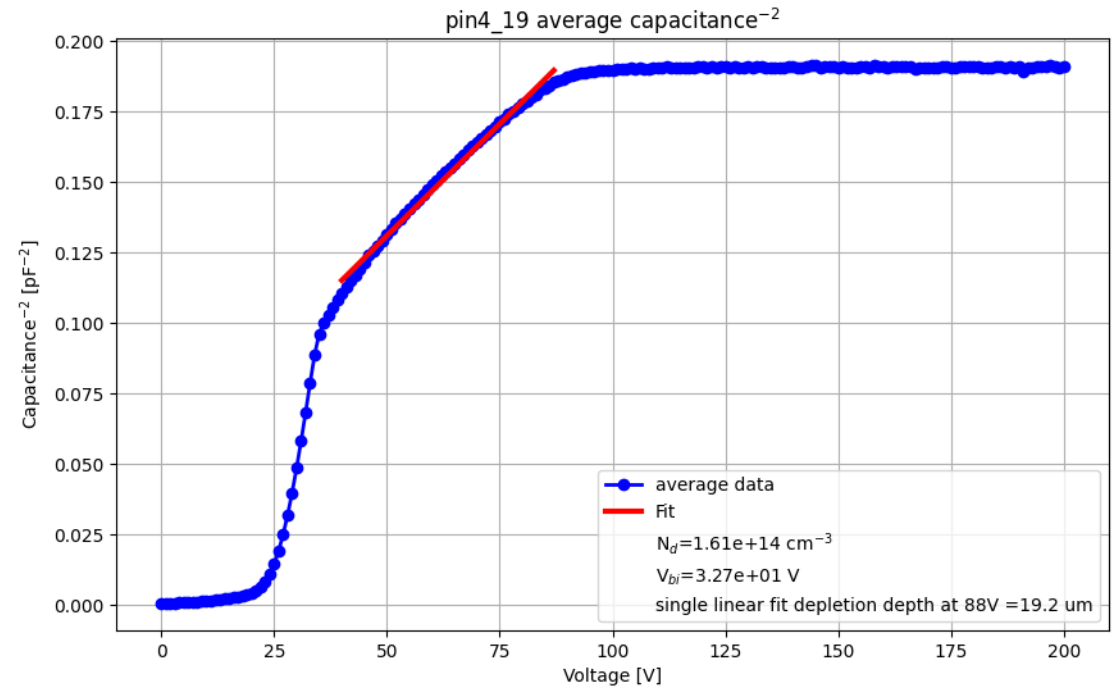
- Temperature and humidity condition same as IV
- Each point measure 5 times and get average value
- Before 40V, not linear change maybe caused by poor metal-semiconductor contact
- 4-18 and 4-20 have very different behavior from 40 to 90 voltage



Doping and depletion depth fit



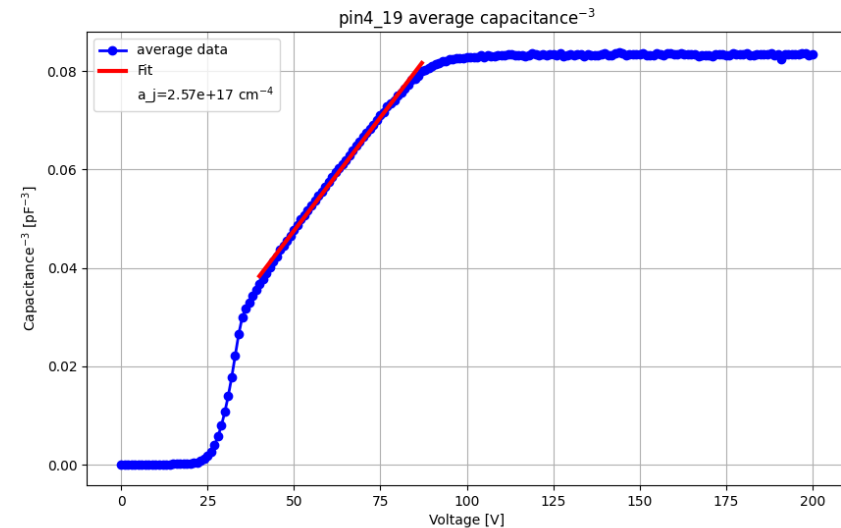
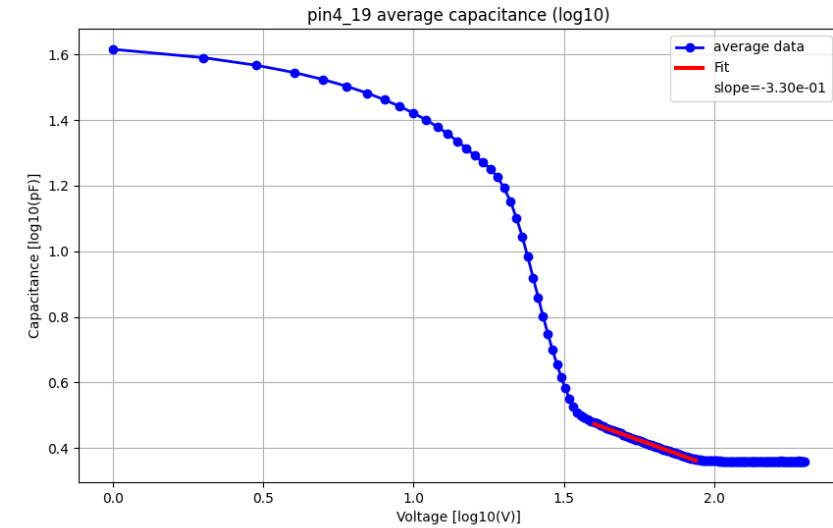
- For ring electrode we use full pad electrode size A to calculate concentration and depletion depth
- Depletion voltage determine: $C_{average} V_d \text{ to } V_{d+5} < 1.01 * C_{average} 100V \text{ to } 200V$
- Use single linear fit ($a*V+b$) from 40V to depletion voltage to get a concentration value $N_d = \frac{2}{q\epsilon_s A^2 a}$
- Built-in field $V_{bi} = b/a$
- Calculate depletion voltage with $W = \sqrt{\frac{2\epsilon_s(V_{bi}-V_{depletion})}{qN_d}}$



Graded junction fit

- $\text{Log}(C)=k*\text{log}(V)*b$ fit k close to -0.33
- Sensor's behavior is more likely graded junction
($1/C^3 \propto V$)
- Graded junction capacitance $C = A * \sqrt[3]{\frac{qa_j \epsilon_s^2}{12(V_{bi}-V_d)}}$
- Fit $1/C^{-3}$ with $a_j * V + z$ to get concentration gradient
 a_j

	4-15	4-16	4-17	4-19
k	-0.317	-0.325	-0.351	-0.330

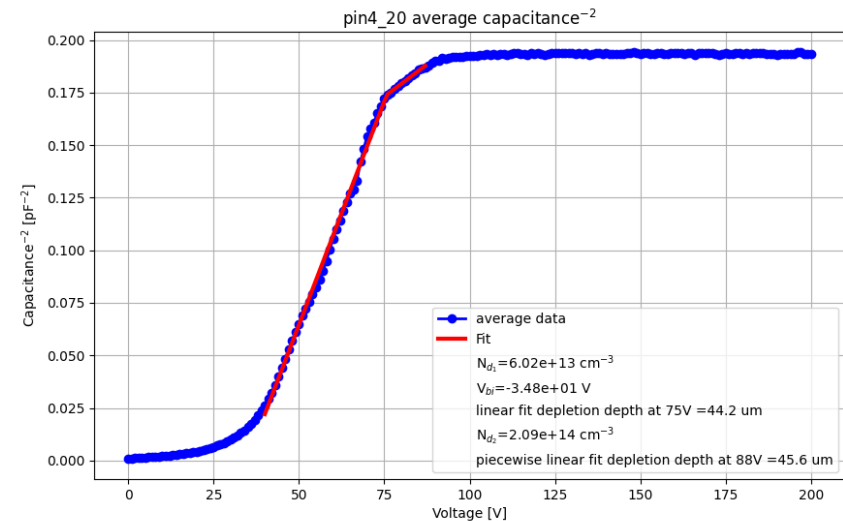
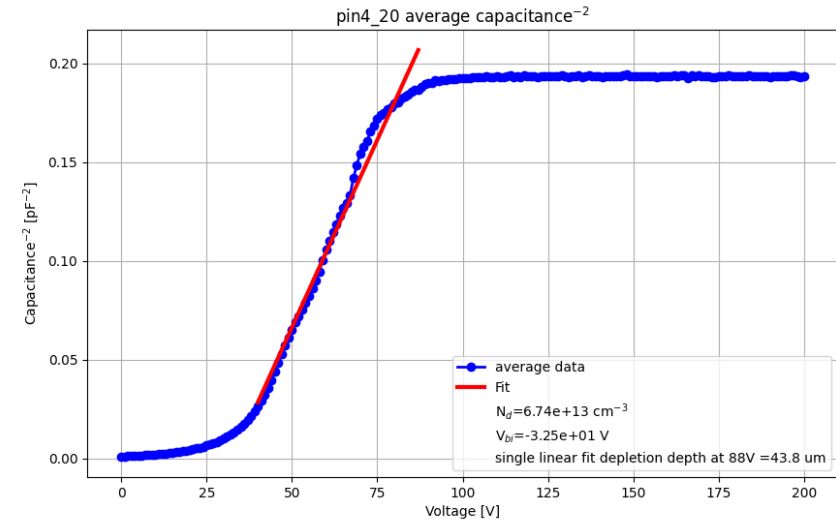


piecewise linear fit with 4-20

- 4-20's $1/c^2$ curve slope becomes smaller as it approaches the depletion voltage.
- Select the slope change point as V_1
- Fit C^{-2} from 30V to depletion voltage with piecewise linear fitting: $(a*V+b)*(V < V_1) + (c*V+d)*(V \geq V_1)$

- $$N_{d1} = \frac{2}{q\epsilon_s A^2 a}, N_{d2} = \frac{2}{q\epsilon_s A^2 c}$$

- $$W_1 = \sqrt{\frac{2\epsilon_s(V_{bi}-V_1)}{qN_d}}, W_2 = W_1 + \sqrt{\frac{2\epsilon_s V_{depletion}}{qN_{d2}}} - \sqrt{\frac{2\epsilon_s V_1}{qN_{d2}}}$$



Sample3 CV measurement results



	electrode type	depletion voltage [V]	depletion depth [μm]	Concentration [cm^{-3}]	Concentration gradient [cm^{-4}]
4-16	ring	90	18.4	1.69e14	2.69e17
4-16	ring	91	18.8	1.71e14	2.75e17
4-17	ring	90	20.6	1.57e14	2.51e17
4-18(bad fit)	ring	94	23.7	1.50e14	2.47e17
4-19	ring	88	19.2	1.61e14	2.57e17
	electrode type	depletion voltage [V]	depletion depth [μm]	Concentration 1 [cm^{-3}]	Concentration 2 [cm^{-3}]
4-20	ring	88	44.5	6.02e13	2.09e14



- Leakage current value shows good consistency with different sensor
- Samples' CV performance are more likely graded junction device
- 4-X series and board will be send to UCSC on 09.March.2025
- Combine simulation results about lateral depletion to recalculate depletion depth (Thanks for Andreas's advice)
- Discussion with factory staff last week, next production will have quality control !



Backup

