EE 236 - Electronic Devices Lab
Lab - 10

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1 Aim of the experiment

To calculate the MOSCAP C-V characteristics and to determine key parameters such as oxide capacitance, oxide thickness, doping density, flat band voltage, flat band capacitance, Debye length, and Debye capacitance.

2 Design

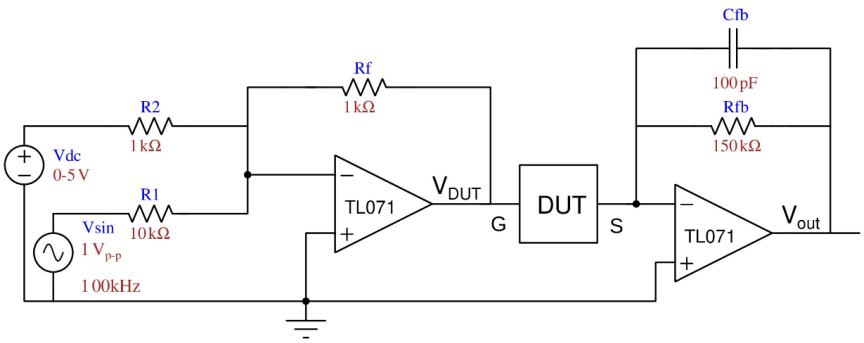

Figure 1: Circuit for measurement of MOSCAP C-V characteristics

We have to measure the capacitance of the DUT, C_{DUT} as V_{DC} is varied from 0 to $5V$ where DUT refers to the MOSCAP sample and G represents the gate terminal, and S represents the substrate.

3 Summer Circuit

The gain of the sinusoidal component is $\frac{1}{10}$, so the expected output was a sinusoid with an amplitude of 0.1 V_{p-p}. Experimentally, the circuit produced a

sinusoid with an amplitude of approximately $105mV$.

4 High Pass Filter

Since this is a high-pass filter, we expect the output amplitude to decrease as the frequency is lowered. Experimentally, the amplitude at 5 kHz was measured to be 55 mV.

5 Calculations

C_{DUT} was calculated using the formula

$$C_{DUT} = C_{fb}\sqrt{1+\frac{1}{(\omega R_{fb}C_{fb})^2}}\ \left|\frac{V_{out\ p-p}}{V_{DUT\ p-p}}\right|$$

AC Gain is $\frac{V_{out\ p-p}}{V_{in\ p-p}}$ with $V_{in\ p-p}$ as $1V$.

$$C_{fb} = 100\ pF \tag{1}$$

$$\omega = 2\pi \times 10^5\ rad\ s^{-1} \tag{2}$$

$$C_{fb}\sqrt{1+\frac{1}{(\omega R_{fb}C_{fb})^2}} = 100.6\ pF \tag{3}$$

V_{DC}	$V_{DUT(p-p)}\ (V)$	$V_{o(p-p)}\ (V)$	gain	$C_{DUT}\ (pF)$
0.5	0.2	0.87	8.7	438.1
1	0.2	0.91	9.1	458.3
1.5	0.2	1.07	10.7	538.1
2	0.2	1.22	12.2	613.0
2.5	0.2	1.25	12.5	628.0
3	0.2	1.26	12.6	633.0
3.5	0.2	1.28	12.8	643.0
4	0.2	1.28	12.8	643.0
4.5	0.2	1.28	12.8	643.0
5	0.2	1.28	12.8	643.0

Table 1: Big Square N Plate

V_{DC}	$V_{DUT(p-p)}$ (V)	$V_{o(p-p)}$ (V)	gain	C_{DUT} (pF)
0.5	0.2	0.76	7.6	382.0
1	0.2	0.9	9.0	450.0
1.5	0.2	1.12	11.2	560.0
2	0.2	1.19	11.9	596.5
2.5	0.2	1.23	12.3	615.0
3	0.2	1.25	12.5	628.0
3.5	0.2	1.25	12.5	628.0
4	0.2	1.25	12.5	628.0
4.5	0.2	1.25	12.5	628.0
5	0.2	1.25	12.5	628.0

Table 2: Large Circle N Plate

V_{DC}	$V_{DUT(p-p)}$ (V)	$V_{o(p-p)}$ (V)	gain	C_{DUT} (pF)
0.5	0.2	0.542	5.42	271.1
1	0.2	0.422	4.22	211.1
1.5	0.2	0.224	2.24	112.0
2	0.2	0.164	1.64	82.0
2.5	0.2	0.156	1.56	78.0
3	0.2	0.152	1.52	76.0
3.5	0.2	0.148	1.48	74.0
4	0.2	0.148	1.48	74.0
4.5	0.2	0.148	1.48	74.0
5	0.2	0.148	1.48	74.0

Table 3: Small Circle P Plate

V_{DC}	$V_{DUT(p-p)}$ (V)	$V_{o(p-p)}$ (V)	gain	C_{DUT} (pF)
0.5	0.2	0.82	8.2	409.0
1	0.2	0.67	6.7	335.0
1.5	0.2	0.41	4.1	204.0
2	0.2	0.31	3.1	155.0
2.5	0.2	0.186	1.86	93.0
3	0.2	0.181	1.81	90.5
3.5	0.2	0.181	1.81	90.5
4	0.2	0.181	1.81	90.5
4.5	0.2	0.181	1.81	90.5
5	0.2	0.181	1.81	90.5

Table 4: Small Square N

6 Plots

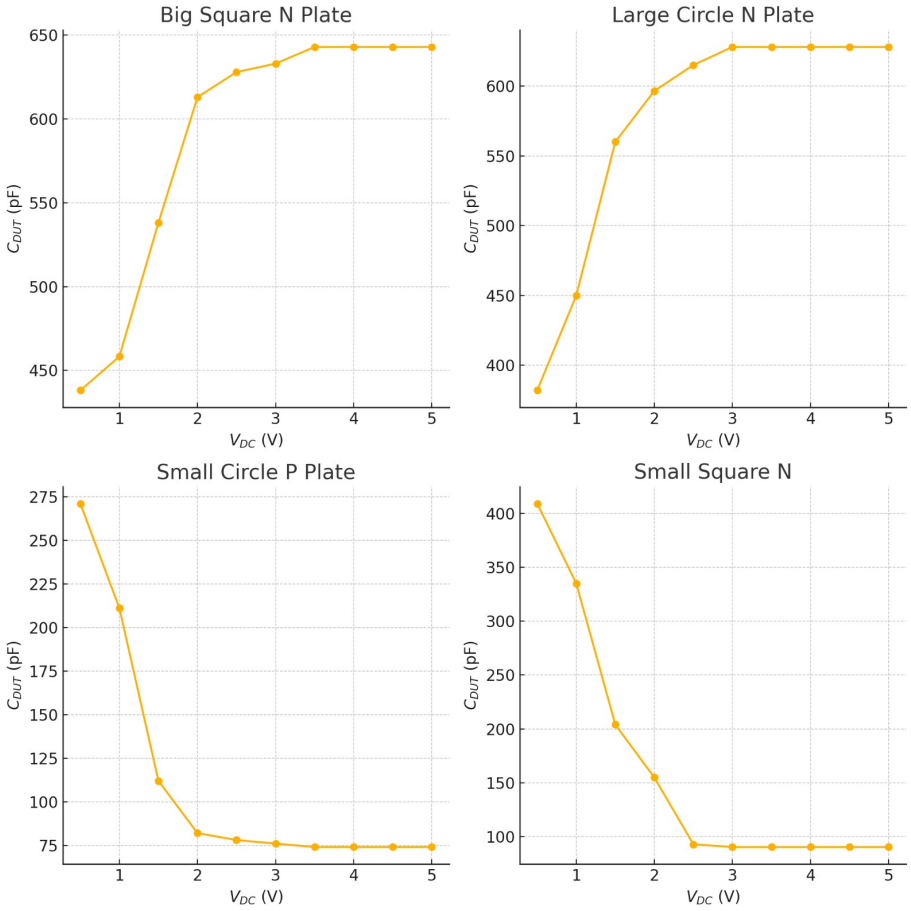

Figure 2: C_{DUT} vs V_{DC}

7 Characteristics

Table 5: Summary of Calculated Values for MOSCAPs

Parameter	**Big N Plate**	**Small N Plate**	**Big P Plate**	**Small P Plate**
C_{ox} (F)	4.09×10^{-10}	4.42×10^{-10}	2.74×10^{-10}	3.94×10^{-10}
t_{ox} (m)	2.65×10^{-07}	3.12×10^{-07}	9.89×10^{-08}	8.76×10^{-08}
C_{min} (F)	2.07×10^{-10}	2.31×10^{-10}	6.61×10^{-11}	9.23×10^{-11}
C_{debye} (F)	1.32×10^{-10}	1.29×10^{-10}	1.57×10^{-10}	1.34×10^{-10}
L_{debye} (m)	2.46×10^{-06}	3.21×10^{-06}	5.18×10^{-07}	7.73×10^{-07}
N (m^{-3})	2.78×10^{18}	1.63×10^{18}	6.27×10^{19}	2.82×10^{19}

7.1 Experiment completion status

Completed the experiment in its entirety in the lab. Completed all sections and found answers to all the questions in the lab sheet.