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Test results for the F–Disk and 90°–stereo Silicon Microstrip Detectors

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Abtract

Up to now 17 F–disk and eight 90°–stereo silicon microstrip detectors classified as grade A are delivered by Micron Semiconductor Ltd. Tests of these detectors similar to [1] are performed and the results are given in this note. The depletion voltage and the leakage current levels are found to be in an acceptable range for the majority of the detectors. Even as for almost all detectors the number of coupling capacitor shorts exceed the specified maximum many F–disk have less than 1% shorts. However many detectors have a too low inter-strip resistance and were send back to Micron for an additional cleaning which may fix the problem.

1 Introduction

Micron Semiconductor Ltd. delivered thirty-seven F–disk wedge and nineteen 90°–stereo detectors so far (01/31/99). Ten F–disk detectors are quoted as preseries, eight are grade B and fifteen are grade A. Eleven 90°–stereo detectors are preseries and eight are grade A. In this note the results of tests (similar to those described in [1]) for the new detectors are presented. The specifications for these detectors are given in Table 1. A brief instruction for these tests is avaiable as [2].

Table 1: The electrical specifications for the F–disk wedge [3] and the 90°–stereo detectors [4].

		F–disks	90° stereos	
depletion voltage	U_{depl}	$= 35 \pm 15$ V		
active area leakage current	I_{leak}	$< 3.6\ \mu$A	$< 3\ \mu$A	at $2 \times U_{\text{depl}}$
junction breakdown voltage	U_{break}	$> 2 \times U_{\text{depl}}$		at 10 μA
guard ring leakage current	I_{guard}	$< 5\ \mu$A		at $2 \times U_{\text{depl}}$
polysilicon bias resistance	R_{bias}	$= 2.5 \pm 0.5$ MΩ		
inter-strip resistance on n-side	R_{strip}	> 2 MΩ	$> 20 \times R_{\text{bias}}$	
capacitor breakdown voltage	U_{coup}	> 100 V	> 150 V	at 2 nA
number of bad strips	$N^{\text{p}}_{\text{bad}}$	≤ 5	≤ 8	on the p–side
	$N^{\text{n}}_{\text{bad}}$	≤ 4	≤ 16	on the n–side
coupling capacitance	$C^{\text{p}}_{\text{coup}}$	> 25 pF/cm	> 16 pF/cm	on the p–side
coupling capacitance	$C^{\text{n}}_{\text{coup}}$		> 21 pF/cm	on the n–side

2 Determination of depletion voltage and leakage current

The total leakage current and the capacitance are measured as function of the bias voltage. The depletion voltage is defined as follows. A straight line is fitted to the capacitance (measured at 10 kHz) between 50 V and 100 V. The lowest voltage where the measured capacity is within three standard deviations of this fit is defined as depletion voltage. This is shown in Figure 1a) for a typical example. Figure 1b) shows the corresponding bias and guard current characteristics.

The results are given in Table 2 and 3. For some 90° detectors (1696-8, 1696-18, 1696-12, 1697-20) the depletion voltage is significantly too low. Two of the 90° detectors (1696-8A and 1696-18C) were found to have Aluminum metalization on the edges which causes very high leakage currents (approximately 1 mA). Further the detectors 1597-25,16 and 1697-19C have a too high leakage current. Another two (mechanical 1696-18A and 1696-8C) were found to have a low breakdown voltage.

3 Coupling capacitor shorts and capacitance

The test for coupling capacitor shorts and the measurement of the coupling capacitance are performed on the semiautomatic probe-station in Lab A. For these tests the detectors are not biased. As the capacitance now is measured on the semiautomatic probe-station all channels can be tested. Coupling capacitor shorts are measured up to 100 V on the

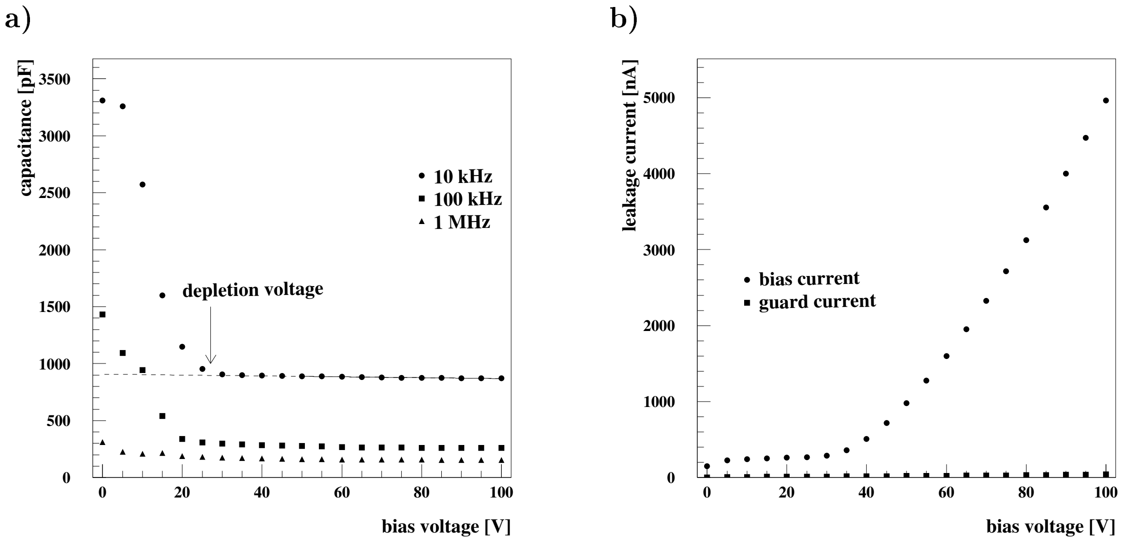

Figure 1: Capacitance and leakage current as function of the bias voltage.
a) Determination of the depletion voltage. b) Bias and guard current characteristics.

p–side and at 10 V for the n–sides. For good capacitors the current has to be smaller than 2 nA. To avoid damaging any strip a current limit of 10 nA is applied to the source unit (Keithley 237).

The results of these measurements are in reasonable good agreement with the measurements performed by Micron. However the number of shorts found on the detector p–sides is significantly higher then the number quoted by Micron. This is because Micron performs breakdown tests only up to ≈ 50 V.

4 Bias resistor and inter-strip resistance

On the n–sides the bias resistor (measured as in [1]) for all tested detectors is found to be between 2 and 6 MΩ, which is acceptable. On the p–sides, however, these measurements gave results which are far below the specifications. Further investigations had shown, that indeed not the bias resistor but the inter-strip resistance is too low (5-20 kΩ) for all of these detectors. A too low inter-strip resistance would result into a to high charge splitting so that these detectors can not be used as production types. Micron claims that these problems occur due to impurities on the “blue tape” used when cutting the detectors and can be fixed by cleaning the detectors in Amide. Detectors in Table 2 labeled as “back” have been send to Micron for this cleaning. Some of the most recent 90°–stereo detectors have a rather low bias resistor (≈ 1 MΩ) on the n–side.

Table 2: The summary of the test results for A–grade F–disk wedge detectors. Most detectors with very low inter-strip resistance are sen back to Micron (labeled as "back"). Some are tested at University Riverside (labeled as "UCR") and Oklahoma ("UO").

detector	grade	$U_{\rm depl}$ [V]	$I_{\rm leak}$ [μA]	$U_{\rm break}$ [V]	$C^{\rm p}_{\rm coup}$ [pF/cm]	$C^{\rm n}_{\rm coup}$ [pF/cm]	shorts p–side	shorts n–side	$R_{\rm strip}$
1597-20	A silox	33(26)	0.4(2.0)	>100	14	15	31(4)	0(0)	back
1597-25	A silox	39(28)	8.3(4.5)	82	16	14	19(6)	3(3)	back
1598-2	A silox	43(36)	3.0(2.8)	>100	17	15	32(2)	3(3)	UO
1597-8	A poly.	22(19)	1.0(0.2)	98	16	15	9(3)	11(12)	back
1597-16	A poly.	21(20)	0.7(0.6)	>100	17	13	6(3)	14(14)	UO
1597-19	A poly.	17(14)	0.6(1.9)	>100	14	14	9(2)	12(16)	back
1597-9	A poly.	36(36)	1.6(9.0)	>100	14	18	10(4)	3(3)	back
1667-9	A poly.	28(27)	1.8(0.4)	98	14	18	6(5)	8(8)	bad
1667-24	A poly.	27(28)	1.2(2.0)	>100	14	17	9(5)	2(2)	back
1667-8	A poly.	29(33)	0.3(2.9)	>100	16	20	11(5)	0(0)	UO
1667-18	A poly.	25(30)	3.5(4.5)	80	16	17	18(7)	4(4)	UCR
1667-17	B poly.	33(34)	0.6(1.9)	>100	16	18	7(5)	1(1)	back
1667-19	B poly.	34(36)	3.6(3.9)	99	15	16	13(10)	8(5)	back
1598-20	B poly.	(45)	(19.6)				(23)	(2)	back
1667-21	A poly.	25(32)	0.7(1.4)	>100	16	16	21(18)	0(0)	back
1676-9	A poly.	(42)	(4.9)				(5)	(4)	back
1677-16	A poly.	26(26)	3.6(1.0)	74	19	20	22(3)	0(0)	back
1676-16	B poly.	(24)	(0.7)				(19)	(4)	UCR
1677-8	B poly.	24(22)	0.9(2.0)	94			(22)	(1)	back
1625-12	A silox	44(50)	28.8	37	18	18	7	5	ok
1655-17	A silox	40(44)	21.1	28			(1)	(4)	ok
1677-11	A silox	34(36)	31.2	7	19	19	5	3	ok

References

[1] Ulrich Heintz, *Evaluation of F-Disk Silicon Microstrip Detectors.* D0 note # 3443.

[2] Peter van Gemmeren, *Test of Silicon Detectors at Micron.* D0 note # 3586.

[3] Ulrich Heintz, *Specifications for F-disk Silicon Detectors.* D0 note # 3342.

[4] Ulrich Heintz, *Specifications for* 90° *Silicon Detectors.* D0 note # 3362.

Table 3: The summary of the test results for preserie 90 degree detectors. The * marks the two 90 degree detectors with metalized edges. Detectors with very low inter-strip resistance are marked as "bad" and as "back" if they have been send to Micron.

detector	grade	U_{depl} [V]	I_{leak} [μA]	U_{break} [V]	shorts p–side	shorts n–side	R_{strip}
1696-8A	pre silox	*(14)	*(4.1)				back
1696-8C	pre silox	11(14)	6.7(4.1)	30			bad
1696-18A	mech.	10	2.7	33	5	0	bad
1696-18B	pre nonp.	12(13)	3.2(3.2)	> 100	9	5	back
1696-18C	pre nonp.	*(13)	*(3.2)		27	8	back
1696-12A	pre silox	9(16)	2.2(2.4)	100	17	1	back
1696-12B	pre silox	8(16)	2.8(2.9)	70		1	back
1696-12C	pre silox	8(16)	2.5(2.5)	60			back
1697-20A	pre silox	18(19)	1.4(1.3)	85	21	2	back
1697-20B	pre silox	13(19)	4(6.2)	45		10	back
1697-20C	pre silox	16(19)	1.3(1.4)	> 100	12	1	back
1697-5B	A silox	30(32)	1.6(1.4)	> 100	2	0	ok
1697-5C	A silox	27(32)	1.6(1.4)	> 100	24	0	ok
1697-7C	A silox	17(35)	2.1(1.7)	90	16	2	bad
1697-12C	A silox	17(29)	1.5(1.6)	> 100	37	8	ok
1697-7B	A silox	23(25)	1.7	> 100	25	1	ok
1697-19A	A silox	26(21)	1.3(1.1)	> 100	10	0	ok
1697-19B	A silox	25(21)	1.3	> 100	8	19	ok
1697-19C	A silox	23(21)	10.0	45	11	1	ok

Table 4: The summary of the test results for the first F–disk wedge detectors [1].

detector	grade	U_{depl} [V]	I_{leak} [μA]	U_{break} [V]	shorts p–side	n–side
1597-11	pre silox	35(20)	1.1(0.6)	> 120	0(1)	1(0)
1598-3	pre silox	46(39)	4.0(5.4)	> 120	(8)	(2)
1598-12	pre silox	25(20)	3.8(2.1)	77	1005(2)	8(8)
1598-22	pre silox	32(22)	3.0(0.9)	> 120		
1597-5	pre poly.	25(20)	2.4(0.3)	90	(> 15)	(23)
1597-13	pre poly.	45(36)	12.8(2.4)	80	(21)	(7)
1597-22	pre poly.	45(35)	3.9(1.4)	> 120	(29)	(7)
1597-24	pre silox	25(21)	1.0(0.6)	115	(20)	(10)
1598-13	pre poly.	50(35)	24.0(2.9)	45	924(24)	3(31)
1598-17	pre poly.	45(34)	8.0(1.5)	100	20(11)	7(8)
1597-10	B poly.	50(36)	11.6(7.9)	95	13(9)	2(2)
1597-14	B poly.	45(39)	5.4(4.7)	> 100	21(19)	6(6)
1597-17	B poly.	40(36)	9.3(5.7)	85	9(9)	6(8)
1597-23	B poly.	27(29)	2.8(4.7)	95	(25)	(12)
1598-5	B silox	45(34)	8.0(4.1)	115	(20)	(27)
1598-6	B poly.	45(35)	21.0(9.4)	45	28(21)	27(4)