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On the cutting edge of semiconductor sensors: towards intelligent X-ray detectors

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Publication date
2012

[Link to publication](#)

Citation for published version (APA):

Bosma, M. J. (2012). *On the cutting edge of semiconductor sensors: towards intelligent X-ray detectors*. [Thesis, fully internal, Universiteit van Amsterdam].

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Measuring I-V and C-V characteristics

Specialised instruments were used for measuring the capacitance (of order pF) and leakage current (of order pA) of the sensor samples studied in Chapter 4.

A.1 Capacitance-voltage set-up

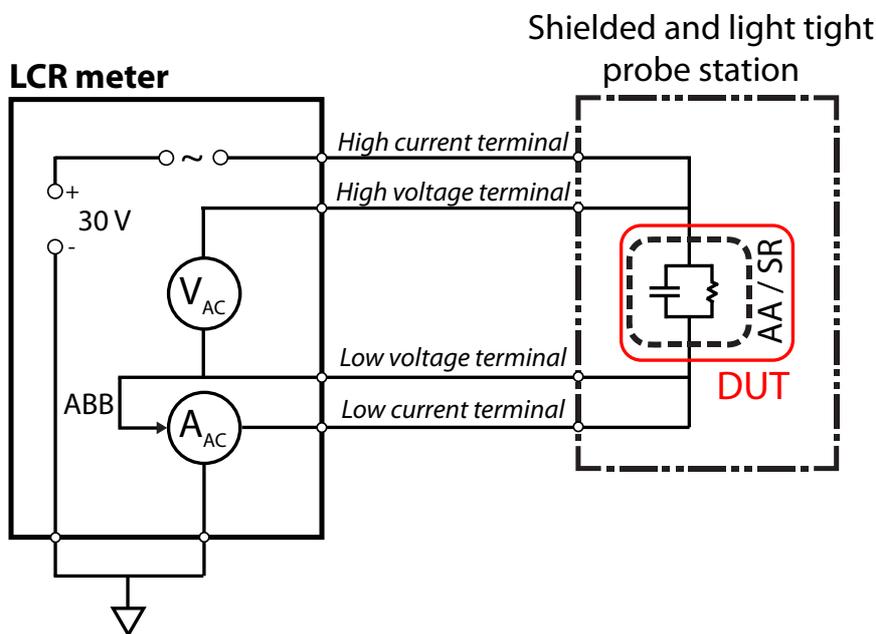
The C-V set-up is diagrammatically depicted in the top part of Figure A.1. It contains an LCR meter¹ that uses the AC impedance technique to measure capacitance. It applies both a DC and small AC voltage to the sensor (denoted as DUT, i.e. device under test) and subsequently measures the impedance, i.e. the magnitude of and phase angle between the AC voltage and current. The imaginary part of the impedance gives the capacitance. The meter uses a so called auto-balancing bridge [121], which ensures virtual ground at the low terminal. Before a measurement is made, the meter is calibrated by determining the circuit capacitance with respect to the ideal capacitance under open-circuit conditions. Furthermore, the shields of the coaxial cables are interconnected close to the probe needles, to ensure that both terminals refer to the same ground potential.

A.2 Current-voltage set-up

The bottom part of Figure A.1 shows the block diagram of the set-up for I-V measurements. The leakage current is measured using source-measure units, which can simultaneously source relatively high voltages (of the order of kV) and measure currents as low as pA's and vice versa. For structures with a p-type stop ring, two source-measure units were used to bias both the active area and stop ring at the same potential and to measure the DC leakage current. Stop rings of n type were left floating.

¹An LCR meter is an electronic instrument used to measure the inductance (L), capacitance (C) and resistance (R) of a device.

C-V set-up



I-V set-up

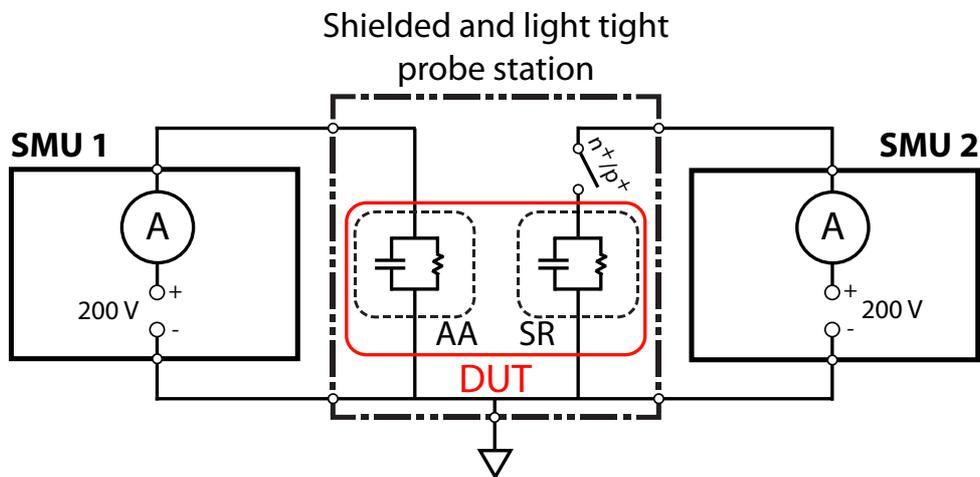


Figure A.1: Block diagrams of the C-V and I-V set-up

The C-V set-up contains an LCR meter to apply both DC and small AC voltages to the device under test (DUT). Subsequently, the AC impedance is measured, from which the capacitance is derived. An auto-balancing bridge (ABB) is used to ensure virtual ground at the low terminal.

The I-V set-up consists of two source-measure units (SMU 1 and SMU 2) that separately apply a DC voltage to the active area and the stop ring and at the same time measure the DC current. For n-type stop-ring structures the stop ring was left floating. Hence the n^+/p^+ switch, which represents the up and down position of the probe needle.