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Relevant and measurable interstrip capacitances for MCMD sensors: Part I

When a strip sensor is covered by a dielectric with a metal plane (GNDP) on top of it as in the MCMD wafers an additional capacitance appears at every strip. Denote the capacitance between GNDP and an individual strip as C_g. If GNDP is grounded an additional capacitance seen by a front-end preamplifier is simply C_g. Note that if GNDP is left floating but all strips are grounded via the electronics the additional capacitance is still C_g because GNDP is effectively grounded via numerous individual strip capacitors C_g.

Consider the effect of GNDP on the interstrip capacitance C_{is} measured in a standard way between a strip and its two nearest neighbours. The equivalent circuit diagram for such a measurement is shown in Fig.1.

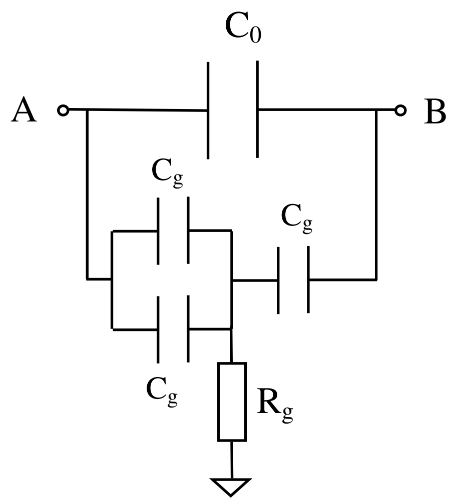

Fig. 1. Equivalent diagram for the C_{is} measurement in the presence of GNDP.

An LCR meter is connected to the points A and B. The C_0 denotes the capacitance without the GNDP, C_g is the mentioned above capacitance between a strip and GNDP, R_g is the resistance from GNDP to the ground. If GNDP is floating ($R_g \rightarrow \infty$) the additional capacitance is $2/3C_g$ i.e. underestimated by 1/3 relative to the additional capacitance which will be seen by a preamplifier. However if GNDP is grounded ($R_g \rightarrow 0$) the capacitances of $2C_g$ and C_g become parasitic capacitances to the ground connected to the LCR input points A and B. The 4-terminal measurement mode used by modern LCR meter suppresses such parasitic capacitances. Therefore the additional capacitance should practically disappear when GNDP is grounded.

To verify this conclusion a dedicated test has been made with a circuit of Fig.1 built from individual components. For MCMD sensors the values of both C_0 and C_g are of ~ 1pF. A nominal value of C_0 in the test circuit was 2 pF (the smallest capacitor available in a standard component form), C_g had nominal value of 2.2 pF and two C_g in parallel were imitated by a capacitor of 4.7 pF. The point between 2.2 and 4.7 pF could be connected to ground via a resistor. The measurements were performed at different frequencies from 1 kHz to 1 MHz.

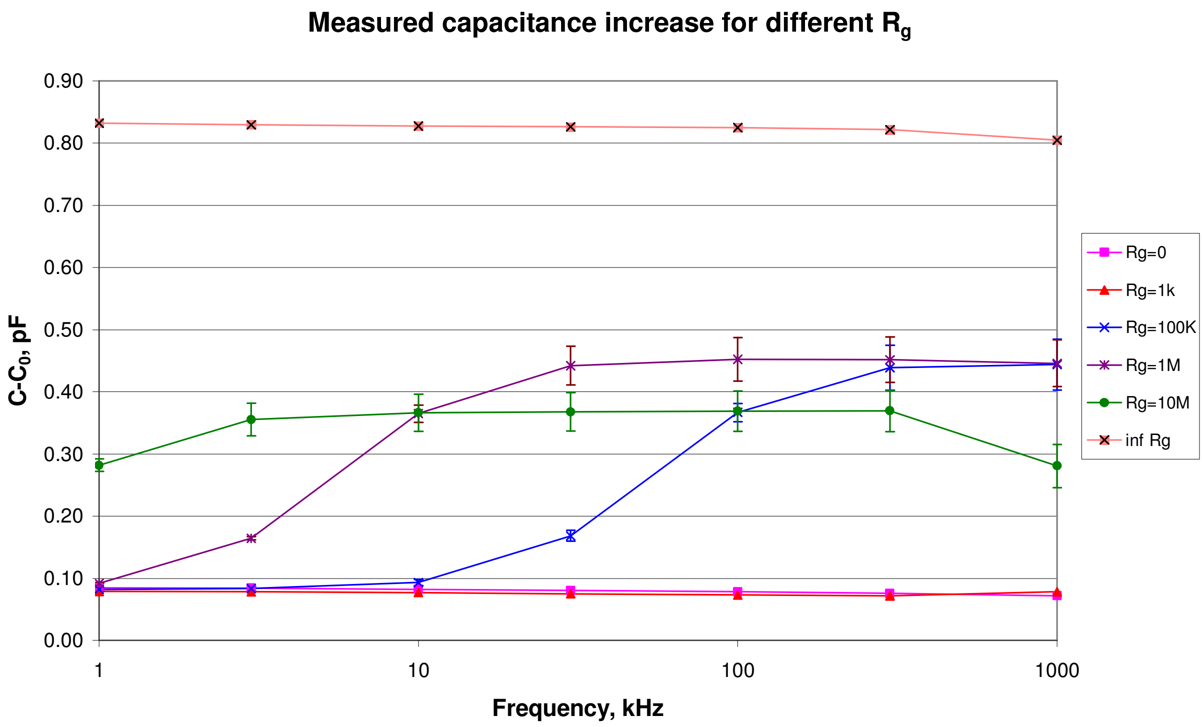

Fig.2 Additional to C_0 capacitance vs. frequency for different R_g.

First the measurements were made with C_0 capacitor only. Its value was found to be ~1.6 pF. Then the second chain of capacitors was added and capacitance was measured for the resistor R_g with one of the following values: 0 Ω, 1kΩ, 100kΩ, 1MΩ, 10MΩ, infinity (no resistor). The capacitance additional to C_0 is presented in Fig.2.

The maximum additional capacitance of ~0.8 pF was observed for infinite R_g . Nominal capacitor values give a bit higher number: 1/(1/2.2+1/4.7)=1.5 pF. However a stray capacitance to the ground of ~ pF may exist in the connector used for R_g connection and reduce the measured capacitance of the additional chain. As expected for small R_g the additional capacitance practically disappeared. The remaining <0.1 pF is probably due to a stray capacitance between the wires soldered to the points A and B when the additional capacitor chain was added. Note that even a large value resistor R_g reduced the additional capacitance by ~ factor 2. This is probably due to a stray capacitance of the resistor itself which might be comparable to the small capacitances used in the test circuit.

<u>In conclusion</u>, the additional interstrip capacitance in the MCMD wafers should be evaluated with GNDP floating rather than grounded. The measurement of the capacitance between a strip and GNDP would also be of interest.