

Preliminary study of electrical characteristics of microstrip sensors



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Introduction

The European X-ray free electron laser (XFEL) will generate ultra short, coherent extremely intense X-ray flashes. It will open up new research topics for scientists, such as mapping the atomic details of viruses, deciphering the molecular composition of cells and movies of molecular transitions.

The XFEL beam will result in a radiation exposure of the detectors of up to 1 GGy from 12 keV photon, which represents a major challenge.

The task is to study the performance of different structured silicon detectors under high X-ray doses. We present first results on the characteristics of microstrip sensors.

Investigated structures

Microstrip sensors:

- high resistivity n-type silicon substrate of 2-5 kΩ·cm
- Diffusion oxygenated float zone material
- <100> orientation
- thickness of $285 \pm 10 \mu\text{m}$
- 98 readout p⁺-strips, with strip pitch of 60 μm, width of 20 μm and length of 7.8 mm

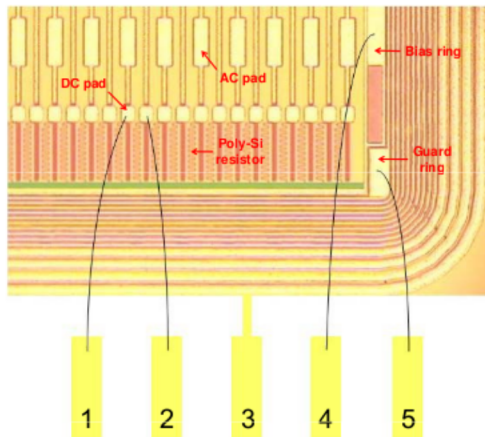
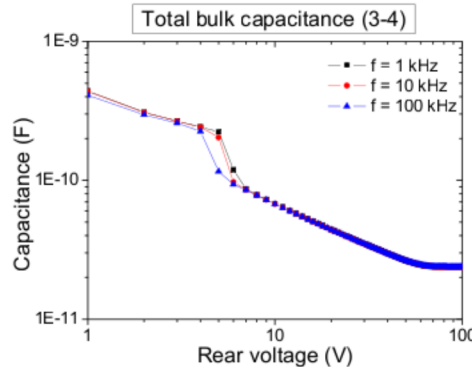


Fig. Photograph of microstrip sensor
Contacts: 1&2 – adjacent strips; 3 – rear plane; 4 – bias ring; 5 – 1st guard ring.

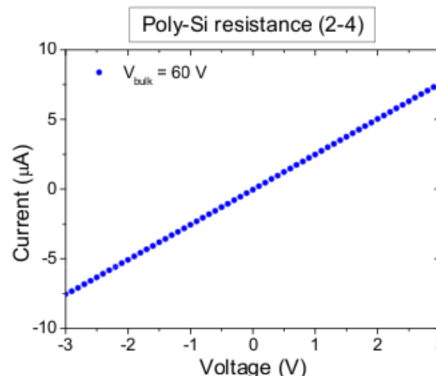
Measurements

- total bulk capacitance
- total leakage current
- poly-Si resistance
- inter-strip resistance
- single strip capacitance

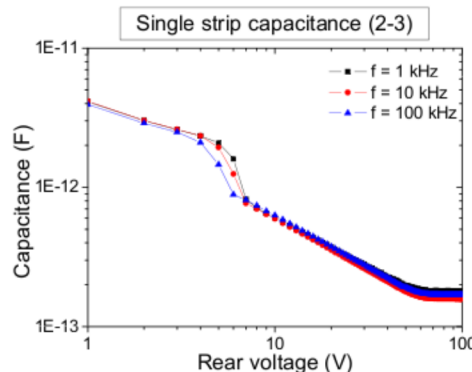
Results for microstrip sensors



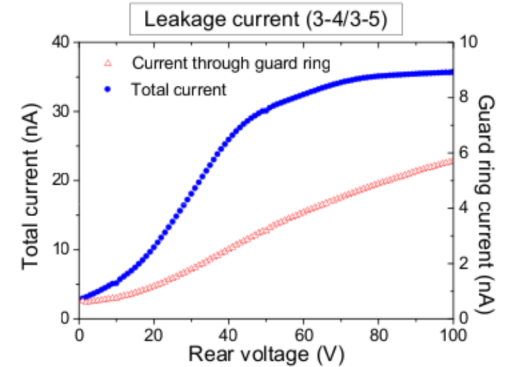
- $V_{\text{dep}} = 57 \text{ V} \rightarrow N_{\text{eff}} = 9.2 \times 10^{11} \text{ cm}^{-3}$
- $V = 6 \text{ V} \rightarrow$ single strip depletion merges



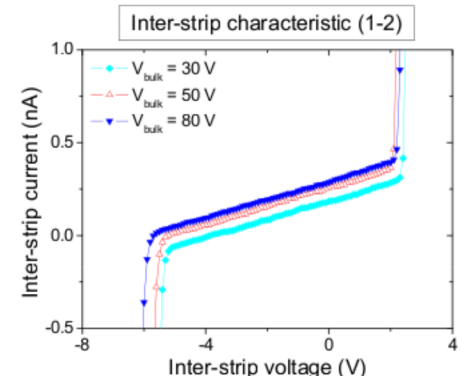
- poly-Si resistance $R \approx 0.4 \text{ M}\Omega$



- $\sim 1/100$ total capacitance \rightarrow strip number



- $I_{\text{leak}} = 35 \text{ nA}$ (at 100 V), nearly an order of 10 greater than the guard ring current

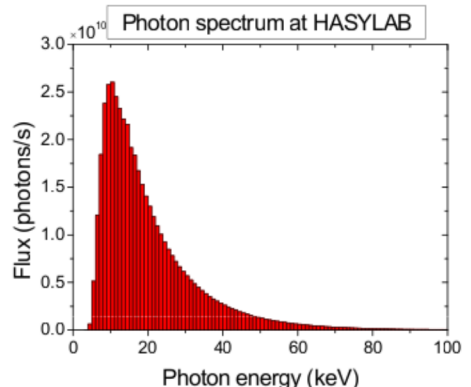


- inter-strip resistance $R_{\text{in}} \approx 20 \text{ G}\Omega$
- Interstrip breakthrough voltage: $-5 \sim -6 \text{ V} / 2 \sim 3 \text{ V}$

Outlook

Irradiation will be performed at HASYLAB beamline F4:

- dose rate variable from 0.5-150 kGy/s
- Beam spot $2 \times 5 \text{ mm}^2$



Next work:

- Above measurements as function of dose D

Acknowledgements

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