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MSGC on substrates with modified surface resistivity

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Abstract

Several technologies for modifying surface resisitivity of thin borosilicate glass D263 are considered. They are shown to enable the preparation of substrates with parameters suitable for MicroStripGas Chamber (MSGC) operation at high rates expected at LHC. We propose thin borosilicate glass with surface modified resistivity as MSGC substrates in ATLAS Forward Inner Detector.

1 Introduction

The surface resistivity of substrate is the most important parameter of MSGC operating at high rates. Two ways exist to obtain suitable surface resistivity:
-to use substrates with bulk resistivity $10^9 - 10^{10} \Omega cm$ (electronically conductive glasses[1]),
-to use a thin resistive layers on insulator supports (silicon wafers with SiO_2, borosilicate glasses). However the glasses with electronic conductivity are rather expensive and are not available in large sizes. The aim of our work is to find acceptable coating for a thin borosilicate glasses substrates.

2 Modification of surface resistivity by thin semiconductive layers

A thin borosilicate glasses (Desag D263 0.2-0.5 mm thick) seems more intresting since they are cheap and available in large sizes (30x30 mm). MSGC on these glasses have been demonstrated a drop of gain at irradiation more than $10^5 count/mm^2 s$ due to large surface resistivity about $10^{17} \Omega/sq$ [2]. The coating of substrates by semiconductive layers of polysilicon and diamond-like layers have been used to decrease surface resistivity to $10^{12} - 10^{14} \Omega/sq$. Technologies used for deposition of thin semiconductive layers are:
-low temperature plasma enhanced chemical vacuum deposition (PE CVD)
-magnetron sputtering

Silicon wafers with SiO_2 layer were used to investigate the technology of PECvd on glasses. The interest to polysilicon is caused by well known properties of this material and its potential radiation hardness. The diamond-like layers produced with clean technologies are under consideration now. The thickness of semiconductive layers was chosen to be 200 - 400 A.

For MSGC the following types of substrates were tested:
-silicon wafers 3" with insulating silicon dioxide SiO_2 (1.5μm) layer produced by PECVD;
-borosilicate glass D263 0.2 mm thick covered by polysilicon using PECVD and sputtering [2];
-borosilicate glass 1 mm thick covered by diamond-like layer.
The mask with active area 50x50 mm have produced in the firm "Angstrem"(Moscow). The anodes and cathods strips are 10 and 90μm correspondingly, pitch is 200μ The aluminium strips 1μm thick were produced by chemical etching. Drift plane was placed 5 mm above substrate.

3 Test results

The surface resistivity of different substrates were tested. In Fig.1 the resistivity as a function of cathode-anode voltage is shown. The tests were done at room temperature by the measurement volt-ampear character just after coating. As it follows from experience of MSGC operation, presented resistivities could provide stable operation at high rates.

The MSGC on glass D263 with sputtered layer of polysilicon have been tested with radioactive sources. The eight anodes strips were connected with one low-noise preamplifier and ADC. The gas mixture Ar/Isobutane (40/60) have been used. The amplitude distribution from Sr^{90} with ionisation equal to minimum ionizing particles is shown on Fig.2. The maximum is corresponded to $45000e^{-}$ (gas gain G=1.710^{3}). The equivalent noises are ENC$\leq 3600e^{-}$, that give us signal/noise ratio about 10.

The time dependence of gain when high voltage was switched on is given on Fig.3 at irradiation $10^{4}count/mm^{2}s$. The good dinamical characteristics of detectors are observed.

The high rate test was performed with X ray tube with 8 keV gammas. The relative gain measurements versus irradiation rate are given on Fig.4. The stable operation of detector have been observed up to rate $10^{4}count/mm^{2}s$. At higher rates slight decreasing of gain was observed. Thus a maximum expected rate for LHC $10^{5}count/mm^{2}s$ can be achieved.

4 Conclusion.

The stable operation of MSGC on thin borosilicate glass with polysilicon coating have been demonstrated for X rays at high rates and minimum ionizing particles. The coating of thin borosilicate glass D263 by semiconductive layers gives possibility to obtain MSGC substrates with surface resistivity in range $10^{12} - 10^{15}\ \Omega/sq$ acceptable for MSGC operation at high rates. There are several types of such semiconductive layers: PECVD polysilicon, sputtered Si, diamond-like layers. The last one shows very promising preliminary test results. Some other groups have the idea to use borosilicate glass with modified surface resistivity for MSGC substrates. The group from ITEP is going to use borosilicate glass instead of suphire substrates with surface modification by ion implantation [2]. Additional tests for all these technologies are necessary. We are planning the long-term ageing tests to choose the materials and technology of substrates coating, also in collaboration with other groups.

References

1. R.Bouclier et al. CERN-PPE/93-04.
2. Proceeding RD-28 meeting at CERN March 22,1994.

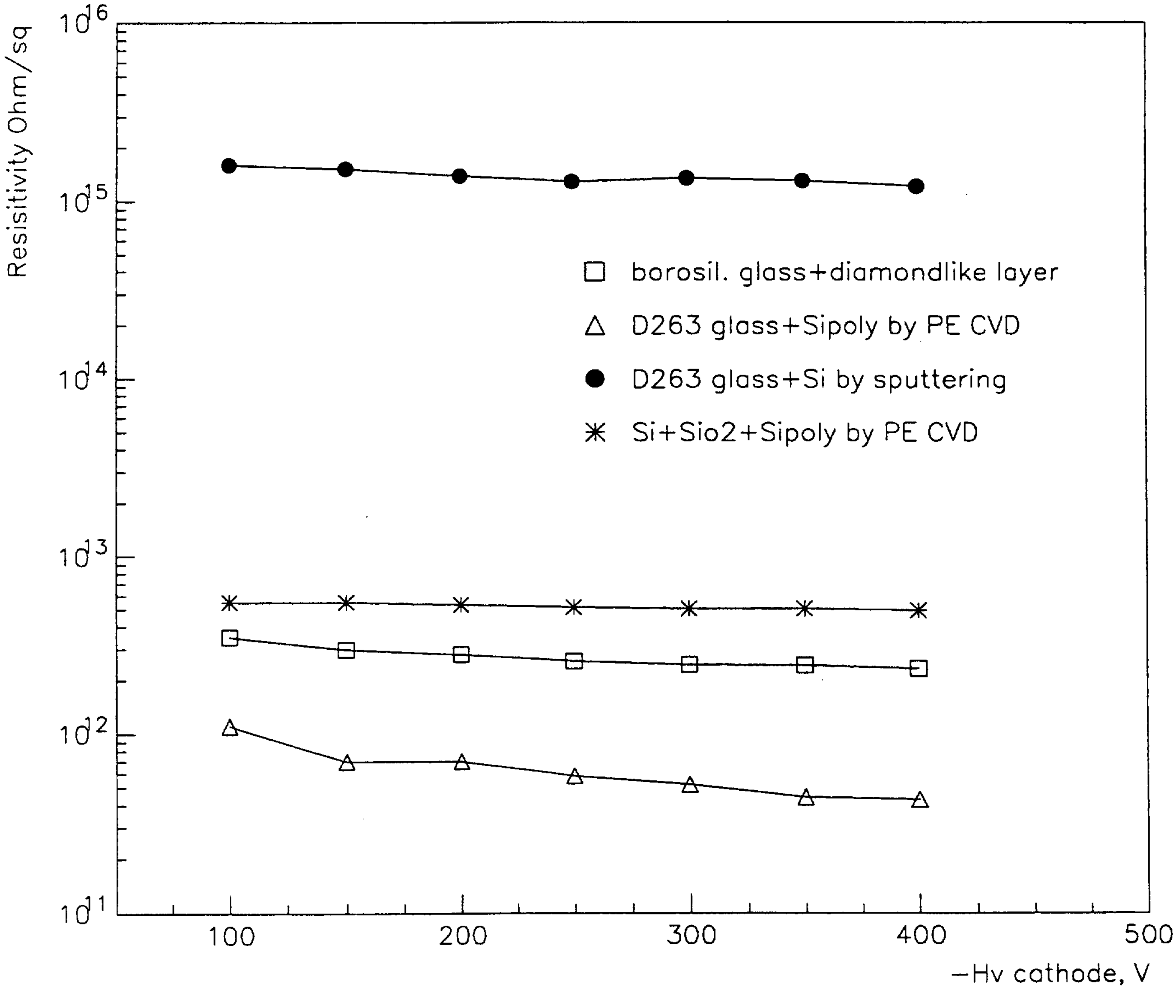

Fig. 1 Surface resistivity versus Hv

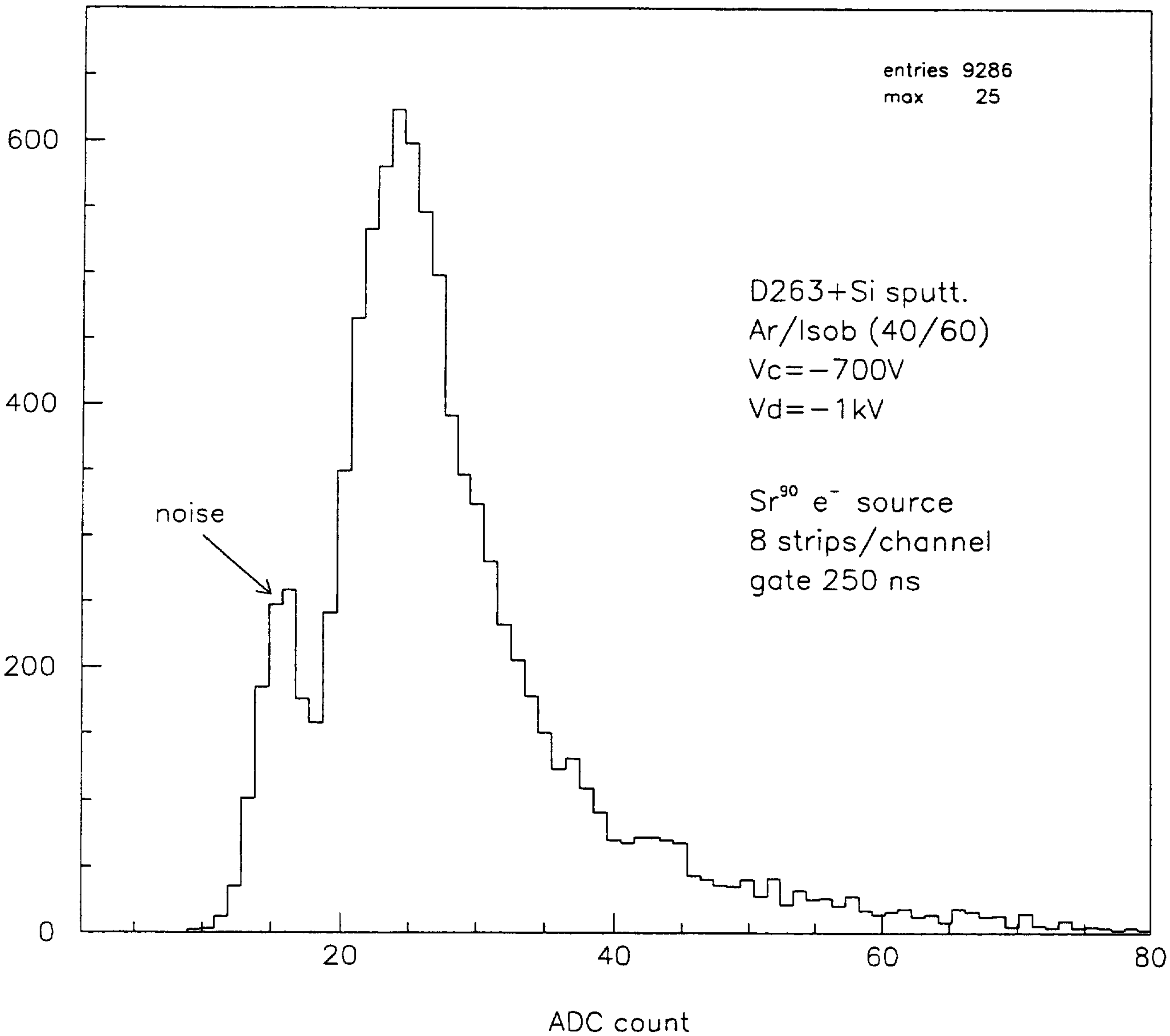

Fig.2 Amplitude spectrum from Sr^{90}

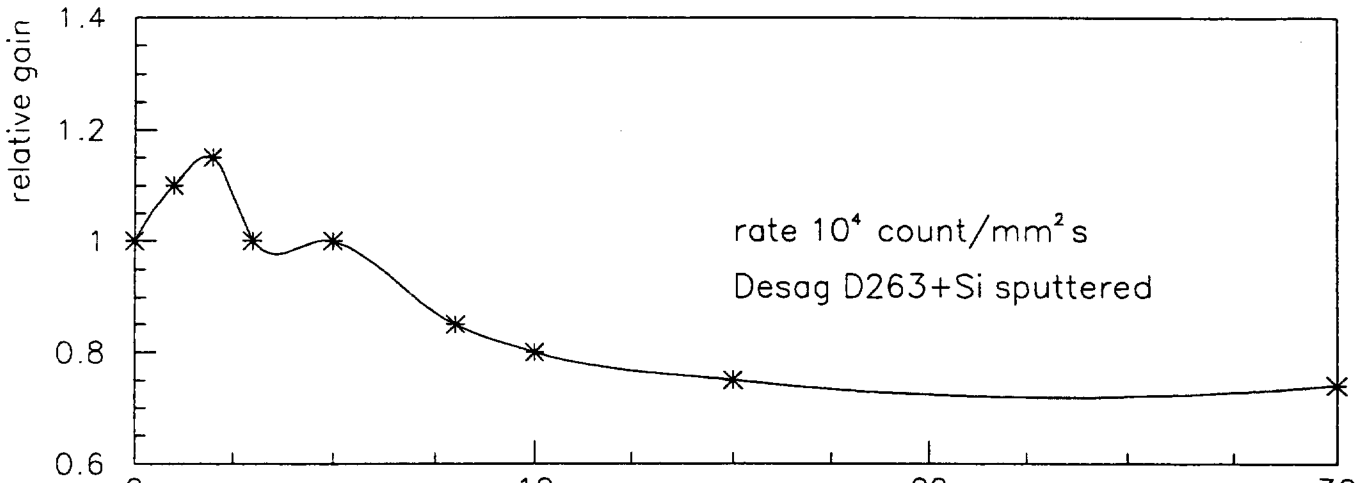

Fig.3 Stabilisation of gain after Hv was switched on

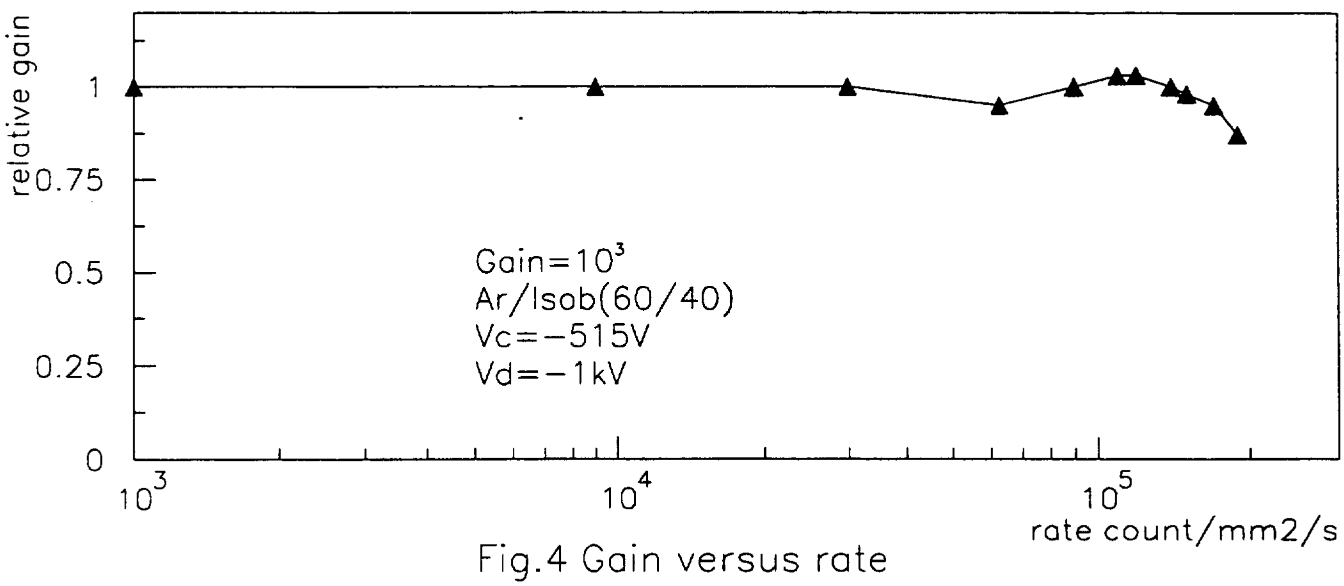

Fig.4 Gain versus rate