[10/09/99 - Painel]

URANIUM TRANSFER TO VEGETABLES: DESIGN AND TEST OF A HYDROPONIC SYSTEM.

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This project is part of the larger and more ambitious one: "Study of uranium biodistribuition in the food chain", which involves experimentation with mammalians (Wistar rats and Beagle dogs), fishes and vegetables (present work), plus extrapolation to humans by means of the General Multiple - compartments Model.
The main idea underlying this project is the simulation of a common real-life scenario, where uranium from fertilizers is transferred to plants and from them to humans. In this regard, a hydroponic system was designed and tested; its main components are:
1) several cubic water containers, 25ℓ capacity, with 15ℓ of argil stones each (to sustain plants);
2) heaters monitored by electronic controllers, in order to keep water temperature constant;
3) electromagnetic pumps to maintain oxygen in the water at normal levels; and an
4) illumination system that mimics a natural photoperiod, controlled by a timer.
A pilot experiment has been initiated with Brazilian lettuce, one weak sowed in a special ground convenient for sowing. Three hydroponic containers were set-up with 12 lettuce plantules (one week old) each. Plant nutrient solutions doped with uranyl nitrate at 20 and 60 ppm concentrations, plus a uranium-free solution, were prepared and administered to each of the 3 groups of lettuces, respectively.
The following parameters were kept constant, or nearly constant: water temperature at $(21\pm_1)$ ^{0}C; water electric conductivity at 2.0 mS, and photoperiod equal to 15h.
One plant from each container is collected every week, its parts are separated (root, leaves, thallus, caulis and veins) and then they are incinerated. The ashes are dissolved in nitric acid; aliquots from these solutions are dropped on Makrofol foils and dried up. These biological samples are irradiated with neutrons near the core of the IPEN/CNEN research reactor (IEA-R1, 5MW, pool type) and the uranium content is determined by the fission track counting technique. These results will make possible to obtain the U transfer coefficients for each part of the plant, as a function of both time and U concentration in the nutrient solution. This is, in principle, the maximum of information one can get for a detailed and complete biokinetics study.

[10/09/99 - Painel]

Influence of a Floating Electrode on the Behaviour of Resistive Detectors in the Proportional and SQS Region

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Introduction

In this work we consider mainly the rate effects associated with the gain and/or the efficiency of detectors with resistive electrodes. Previous results [1,2] showed that the loss of pulse height that is observed when such a resistive detector is operated under increasing detector current can only be ascribed to the reduction of the effective voltage difference across the gas. Indeed, as a consequence of the resistance of the lossy dielectric that constitutes the cathode, the voltage applied is reduced by a predictable amount which can be easily computed under the assumption

that the symmetry (homogeneity) of the charge build-up and collection over the cathode surface is maintained. The motivation for the present work was to study to what extent this interpretative model can be extended to operating regimes where the charges developed in the avalanches are significantly larger, and to consider if the discontinuity associated with the threshold for the transition between the proportional and the streamer mode can similarly be accounted for. The present technique relies on the direct comparison of data obtained in detector fitted with resistive electrode and in a metallic detector which has exactly the same geometry and operates under the same conditions.

The Experimental Setup

A long cylindrical counter made of glass $\phi_i = 12.7$ mm, wall thickness = 1.1 mm and resistivity ($7x10^{12}$ Ohm.cm) fitted with a stainless steel anode wire $\phi = 50$ (μm) was used. In a small region of the part painted internally, conductive painting was also apllied externally for a length of 31 mm and connected to ground. The internal Aquadag electrode may be grounded or not. In the first case, the tube behaves as a conventional metallic proportional detector and will be designated MD. In the second case, the internal cathode is truly floating, i. e., it is not connected externally to any passive ar active electronics, and we designate it as the floating electrode resistive detector, FERD. The Ar/CO_2 (45:55) gas mixture has been used for the measurements related to the transition from the proportional to the self quenching mode, whereas the measurements in the proportional regime where taken with P-10 (argon with 10% CH_4). X-rays from a ^{109}Cd source (22 keV) irradiate the detector through its glass wall. The charge spectra were measured using a conventional charge amplifier electronic system and a multichannel analyzer.

Proportional Mode

The behaviour of the resistive detector (RD), operating in the proportional mode under a stationary regime, was reported in a previous work [3]. Similar measurements were performed with the floating electrode resistive detector (FERD). The curves of the variation with the rate of the mean charge amplitude for both the RD and the FERD detectors operating with P-10 shown a descent behaviour which is only due to the drop of gain in the RD and FERD detectors. We should stress that, for this voltage and for all the rates, there are no space charge effects. Therefore, the gain in the MD remains constant.

Transition to Streamers

Typical charge spectra in the transition region shown that at $V_o = 2850$ V and under a rate of 90 events per second, the FERD detector is clearly above the onset of SQS avalanches, whereas at $V_o = 2950$ V it approaches the conventional transition voltage (i.e., half of the events give rise to proportional/saturated avalanches while the other half develop SQS). The mean charges corresponding to the proportional, saturated and the SQS peaks observed both in the MD and the FERD as a function of the applied voltage shown clearly the loss of the pulse height along the proportional and the standard regions, being more pronounced for the higher rate. Accordingly, and in qualitative agreement with our model, the onset of the SQS avalanches is situated 100 V higher for the FERD operated at 90 Hz than for the MD, and again 100 V further for the FERD at 420 Hz. Under the above mentioned assumption, our model can be used to compute the quantitative correction to apply to the data. This was done, and the same data, as a function of V_{eff} (calculated according to the relation $V_{eff} = V_o - RI$), shown that the SQS onset on the FERD for the two rates now falls close to the voltage observed for the MD. The same type of measurements were also done for the case of RD. We may remark that, even for three voltages situated 50 V above the values selected for the FERD, the fraction of events developing into SQS in the RD is very small. On the other hand, the definition of the SQS peak is also very poor. These two observations are compatible with the difficulty in reaching a field around the anode wire strong enough, now that the removal of the charges deposited on the cathode walls is obviously more difficult than in the previous case of the FERD. In this case the cylindrical symmetry is lost due both to the low rate of SQS pulses and to the fact that the SQS avalanche is very localized.

Conclusions

The results obtained with the resistive detector concerning the gain in the proportional region and the threshold for the transition into the streamer mode agree well with the model proposed, essentially a voltage loss in the dielectric. This was accurately calculated because the experimental conditions were carefully chosen to allow simple and

reliable computations. This type of information is practically usefull as it can be applied to any type of geometry. It should be stressed that the model fails if the cylindrical symmetry is lost, and this happens in the RD detector as soon as the streamer starts to be seen, on the regions of 1 or 2%.

References

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[10/09/99 - Painel]

Study on Avalanche Gain and Charge Collection in Microgap Detectors at High Pressure

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Introduction

Microstrip and microgap gaseous detectors operated at high pressure have been considered for the development of 2D devices with low granularity, efficient in an energy range of up to 25 keV in detectors for medical applications and synchrotron radiation [1-3]. We have reported that even when using microgaps with narrow anodes (4 μm) the safe maximum gain at 6 bar at high rates is low (under 200) [4] and that in order to be used in practical detectors these devices should be used, with a preamplification structure such as the recently developed gas electron multiplier (GEM) [5]. It is known that space charge effects are important to proper GEM operation and that, in order to avoid recombination at high pressure, the typical drift fields are much higher than at atmospheric pressure. Considering the great interest of those preamplifying structures, we decided to study the dependence of the charge collection on the drift electrode at several pressures using gaseous mixtures containing heavy gases, such as krypton, at various counting-rates and gains. Since our previous work has shown that the anode and insulator width is of great importance for high-pressure operation of microgaps, their influence on the drift current is also considered.

System Description

A stainless-steel chamber and a clean gas system were used. Special care was taken to keep the gas impurities to a minimum. Two series connected picoammeters (Keithley 602 and 414s) were used for simultaneous measurement of the anode and cathode currents. The drift electrode current was computed from the difference between these two values. The distance between the microgap surface and the drift electrode was 5 mm. The electrodes were made of aluminum and the insulator is silicon oxide of 3 μm thickness. The anode pitch is 100 μm and several anode and insulator widths were used. The measurements were performed with a beam energy of 12 keV using an X-ray generator. The gain was calibrated either by the pulse amplitudes or by the current and count rate measurements.

Experimental Measurements

During all the measurements the gas mixture was Kr-10%CO_2 and the gain was set at 150 within an error of less than 10% at a drift voltage of 1000 V. As expected, the drift current also depends on the value of the drift voltage. The ratio of the drift and anode currents for two count rates and two different anode layouts versus applied drift voltage shown that when using the wider anodes and insulators the anode voltage is higher than with the narrower ones, and this can explain the observed difference in drift currents. At high counting, the variation of the ratio between the drift and anode current with the counting rate, for several drift voltages, is such that the reduction of this ratio at the maximum counting rate (about 5%) seems almost independent of drift voltage. The variation of the ratio between the drift and anode current versus counting rate using four different microgap layouts were studied. The general trend of the preceding results appears again, wider insulators yield higher drift currents and