Gas-Chromatographic Analysis of Organic Compounds Formed in Avalanches Around Wires

(title assigned)

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Some organic chemical compounds formed in electron avalanches have been analyzed by using a tandem gas chromatograph equipped with a cryogenic sample concentration unit. The characteristics of the analyzer are described. An analysis of compounds created in a single-wire proportional counter filled with Ar/C_2H_4 50:50 gas mixture is presented. Simple reaction kinetics for some of the compounds observed is discussed. Examples of using the system for studying outgassing of various materials and effects of additives are given as well.

Summary of Talk: A large amount of organic compounds and radicals are involved in the chemical processes occurring in gaseous radiation detectors. Some of these reactions produce large molecular chains forming polymer structures on anode or cathode surfaces. Identification of organic compounds being formed in electron avalanches may help us to understand the basic chemical processes causing these aging effects. We have assembled a gas analyzing system consisting of two gas chromatographs and a cryogenic sample concentration unit. The sample is taken from the gas output flow of the gaseous radiation detector under investigation. It is concentrated in a cryotrap cooled by gaseous nitrogen that is itself cooled by liquid nitrogen. To be able to analyse small concentrations of organic compounds in a gas mixture where a significant part of the mixture is an organic compound itself, a precise temperature control of the cryotrap is needed. A heated single wire counter with a continuous gas flow was used in the study. The counter was filled with a Ar/C_2H_4 50:50 gas mixture working in proportional mode. An X–ray tube with Cu target was utilised as a radiation source. The anode current of the counter, which was measured continuously during the irradiation, was typically a few hundred nanoamps. The sample trapping time and the irradiation time varied from a few minutes to three hours resulting in an integrated charge of a few millicoulombs at maximum. Fifteen new organic compounds were identified in the gas mixture. Production of most of them may be explained by simple chemical reactions. Some of these compounds have double or even triple bonds, which are easily opened and may start to form longer molecular chains. Literature survey revealed that the triple bond compound found is known to polymerize very aggressively. In the accelerated aging tests, a presumption is made that the chemical environment in electron avalanches is independent of the irradiation rate. Validity of this presumption is studied by measuring the production rate of the avalanche compounds as a function of the irradiation rate.