Fine Structure of the Charged Particle Bursts Induced by D_2O Electrolysis

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Abstract

Internal structures of charged particle bursts induced by the D_2O electrolysis have been studied by use of a fast response measurement system. Charged particles were detected by a NE102a plastic scintillation counter. The electrolysis was continued at low temperature at 4°C for 3 hours. After then, the cell was warmed up to several ten degrees of Celsius scale. During the warming-up, we caught some anomalous pulse emissions of charged particles. The pulse shapes of the bursts were found to be complicated and the duration of the bursts was distributed from 40 to 100 nanosecond. Comparison of these pulse shapes and standard response for a single particle suggests that the burst is a pile-up pulse and consists of many particles.

1. Introduction

Emissions of neutron bursts were reported frequently in the cold nuclear fusion experiment. Especially in the Ti+D_2 heat cycle experiments, intense neutron bursts with the time scale of microseconds were reported[1]. However, the detail of the timing structure of the bursts have not been measured. When the duration of the bursts would be short, energy spectra of the bursts are also difficult to be measured. Conventional pulse height analyzing system gives only a total energy of bursts. It can not analyze the pulse height of individual pulses separately. In any case, the timing structures of the bursts are considered to be important for understanding the reaction processes of the cold fusion. The energy spectrum of the particles is also indispensable for identification of the type of the reaction. Previously, we have studied the cold fusion phenomena by use of the charged particle method[2], and observed some charged particle bursts[3]. This paper is concerned with the investigation of the

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pulse shape of the charged particle burst by use of a fast response measurement system.

2. Experimental System

Figure 1 shows the electrolysis cell used in this experiment. A NE102a scintillation counter as a charged particle detecter was attached to the cathode foil with a gap of 5 mm. Figure 2 shows the pulse analyzing system. Output current pulses of the photo-multiplier are integrated by a charge sensitive amplifier and the pulse-height is analyzed with the PHA(Fig.2(a)). In addition, the fast response measurement system is prepared in the present experiment (FiG.2(b)). The output current pulse of the photo-multiplier is amplified by a wide-band current pulse amplifier without integration. The pulse shapes were recorded in a digital strage oscilloscope. A 20 μm thick palladium foil was used for the cathode and set at the bottom of the electrolysis cell. 0.1 μm thick Ag layer was deposited on the air side surface of the cathode foil. The solution used was D_2O+ 0.1moldm^{-3}LiOD. The temperature control of the D_2O solution was programmed to follow a desired pattern. After the electrolysis at low temperature, 20 mA at 4°C for 3 hours, the cell was warmed up to several ten degrees. Abnormal charged particle emission was observed during the warm-up of the solution. Energy spectrum and the pulse shape of the burst were measured simultaneously.

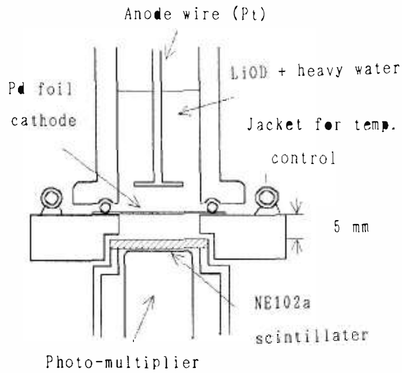

Fig.1 Electrolysis cell and the charged particle detecter.

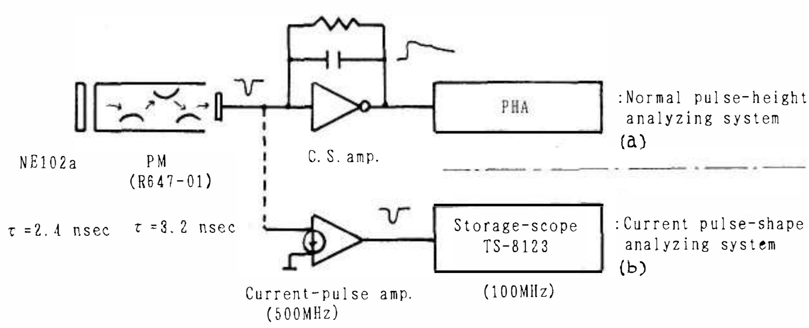

Fig.2 Conventional PHA system and the fast response measurement system.

3. Results and Discussion

Figure 3 shows the energy spectrum measured by the conventional PHA system. The spectrum shape was featureless. The pulse shapes of the slow outputs of the charge sensitive amplifier were not different from the normal response. However, the pulse shape of the burst were completely different from that of the standard alpha particle shown in Fig.4(c). We obtained only two pulse shapes of the burst. Figures 4(a),(b) show the pulse shapes of the bursts. The burst seemes to have some complicated structures. We supposed that the structure of the burst was attributed to the pile-up of many pulses. We restored them to the original timing structure by use of an unfolding method. The restored pulse shapes are shown on the upper side of the Figs.5(a) and (b), respectively. The dotted curves shown in the figures indicate the reconstructed pile-up shapes when the standard responses are appeared and piled-up according to the restored timing strucure. The small dotted curves in the same figures show the burst shape measured in the experiment. Comparison of these curves seems to support our supposition that the burst is the pile-up of the pulses. It is slightly complicated to estimate the energy of the tiny pulses participated in the burst. The light response of the NE102a scintillater is depend on the species of the particles. An energy scales are plotted on the left side of the frames of Figs.5(a) and (b), on the assumption that the particles were electrons. On the opposite side, the scales for protons are plotted. In the case of proton, the energy of the particles should be distributed from 0 to 1.5 MeV, while in the case of electron, that is distributed from 0 to 0.3 MeV. In the proton case, the energy distribution is consistent with that the D-D reaction occured in the palladium foil cathode. The particle identification is indispensable in the study of cold fusion. Futher experiment are in progress.

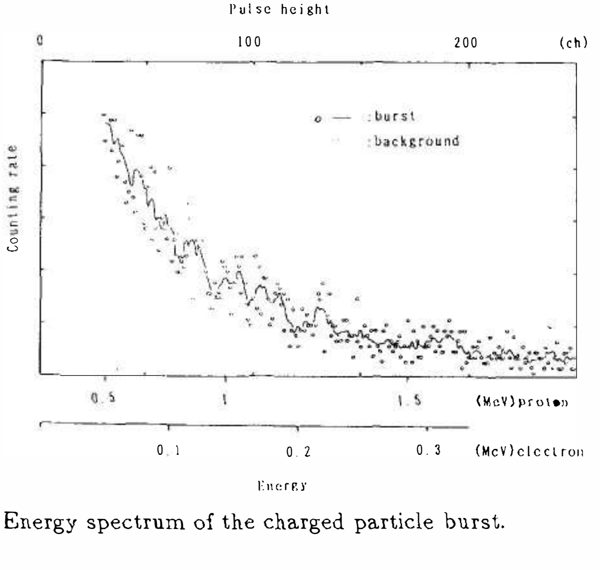

Fig.3 Energy spectrum of the charged particle burst.

Acknowledgment

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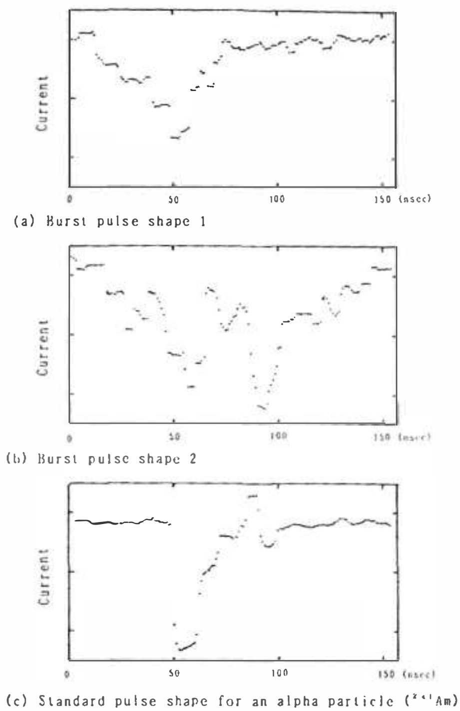

Fig.4 Pulse shapes of the charged particle bursts and a standard pulse shape.

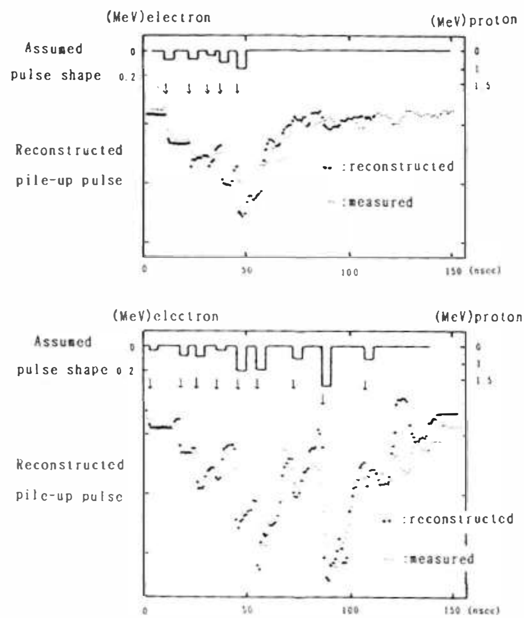

Fig.5 Presumption of the original timing structures of the bursts, and comparison of the reconstructed pile-up shape to the measured pulse shape.