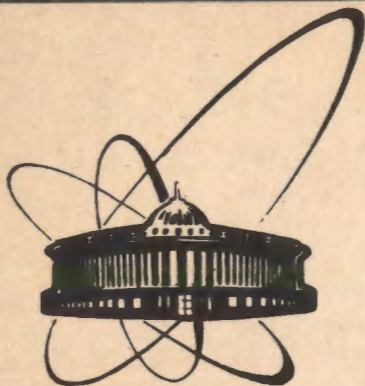


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REGISTRATION PROPERTIES
OF DIFFERENT TYPES OF CR-39
IN VACUUM CONDITIONS OF IRRADIATION

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1. INTRODUCTION

It was shown in a number of papers (Drach et al., 1987 a,b; Csige et al., 1990; Csige et al., 1988; Fujii et al., 1987; Kumar et al., 1986; Somogyi et al., 1986) that the long holding time of CR-39 plastic in vacuum conditions before and after irradiation with charged particles decreases its registration sensitivity and etch rate ratio, V ($V = V_T/V_B$, V_T - track etch rate, V_B - bulk etch rate). One associates this effect with a decreasing of dissolved oxygen concentration profile inside the detector at a latent track formation (Csige et al., 1988; Fujii et al., 1987; Somogyi et al., 1986). By now, a polymer behaviour of different producers has been investigated and one has observed that this effect depends on composition and method of material production and also vacuum conditions and value of particle ionization. In all experiments the residual pressure did not diminish 10^{-1} Pa, time intervals of outgassing were from a few minutes (Somogyi et al., 1986) up to 25 days (Drach et al., 1987 b). However, during physical experiments the detector should be placed very often in vacuum chamber with residual pressure less than 10^{-2} Pa. In the present paper some preliminary results on sensitivity change of four types of CR-39 in different vacuum conditions are presented.

2. EXPERIMENT

The CR-39 samples of Pershore and Tastrak (England), Intercast (Italy) and MOM (MA-ND/ α - detector, Hungary) having a thickness of about 0.7; 0.4; 1.4 and 0.8 mm, respectively, were used. The α -particle irradiation with the energy $E_\alpha = 5.5$ MeV was being performed from thin ^{238}Pu -source and by charged ions with atomic number $Z=2+10$ at the energy $E=9.1$ MeV/nucleon using the cyclotron

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y-200, JINR (Dubna). The aluminium foils were used for particle energy degradation. The angle of particle incidence was 45° and 90° relative to the detector surface. The detectors were placed in vacuum chambers in which during about 30 min. the pressure of $\approx 5 \cdot 10^{-3}$ Pa and $\approx 2 \cdot 10^{-2}$ Pa at irradiation by alphas from ^{238}Pu and ions, respectively, was being established. Holdup time of detectors in vacuum chamber before irradiation was being varied from 0.5 up to 11 hrs. Then the irradiation followed which was about 20 min. by using ^{238}Pu and 15 sec. operating at accelerator. After irradiation the samples were being held up in vacuum chamber 30 min. more. The detectors were etched at 70°C in NaOH solution with concentration of 4.85 N and 6 N. The measurements of geometric parameters of etched tracks were performed by means of MOP-Videoplan (Austria) image analyzer. Standard deviation from mean value for all track parameters was $0.2+0.3 \mu\text{m}$. The bulk etch rate of detector material was determined by method of weighing and by diameters of highly ionizing particles.

3. RESULTS AND DISCUSSION

In Figures 1 and 2 the results of investigation of outgassing time of influence on track diameter of α -particles are presented. The bulk etch rate did not depend on vacuum conditions, so one can consider the track diameter decrease as the decrease of the track etch rate and detector sensitivity, respectively. In Figure 1 one can see that CR-39 of Intercast Company (Italy) within investigated period of holding time in vacuum before α -particles irradiation (9.1 MeV/nucleon) does not change its sensitivity. The rest types of CR-39 showed the different degree of its decrease. It turned out that CR-39 of Pershore was the most strongly undergone that effect. This type was chosen for more detailed studying of this effect. In

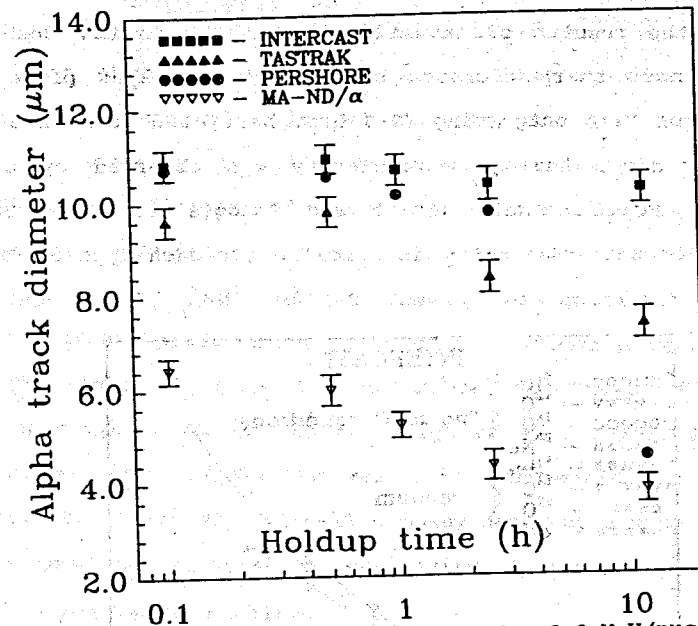


Fig.1. Variation of alpha track diameter ($E_\alpha=9.1$ MeV/nucleon) with holdup time in vacuum chamber ($P \approx 2 \cdot 10^{-2}$ Pa) before irradiation for four types of CR-39. For Pershore detector no errors bars are indicated, but standart deviation is $\approx 0.25 \mu\text{m}$ also.

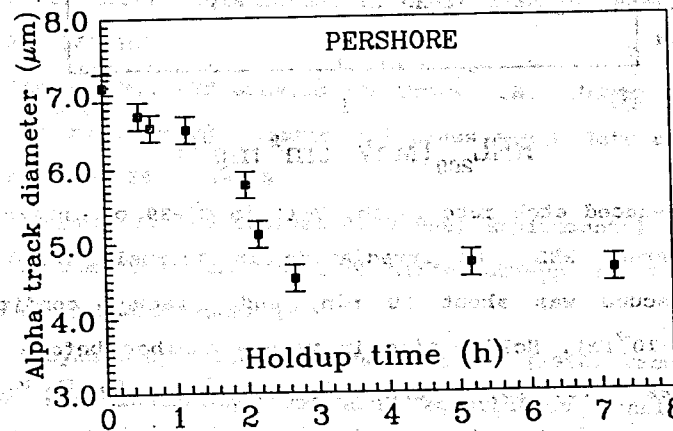


Fig.2. Alpha track diameter ($E_\alpha=5.5$ MeV) for Pershore detector versus holding time in vacuum chamber ($P \approx 5 \cdot 10^{-3}$ Pa) before irradiation.

Figure 2 the results of investigation are presented. One can see that the most sharp decrease of sensitivity takes place at the beginning of time outgassing (2-3 hrs. here) and then this process is slowed down. Analogous regularity was observed by Csige et al. (1988), Fujii et al. (1987) and Somogyi et al. (1986). The behaviour of this regularity is specific for each type of CR-39. In Figure 3 the response curves, $V-1$ vs. REL_{200} , for most stable

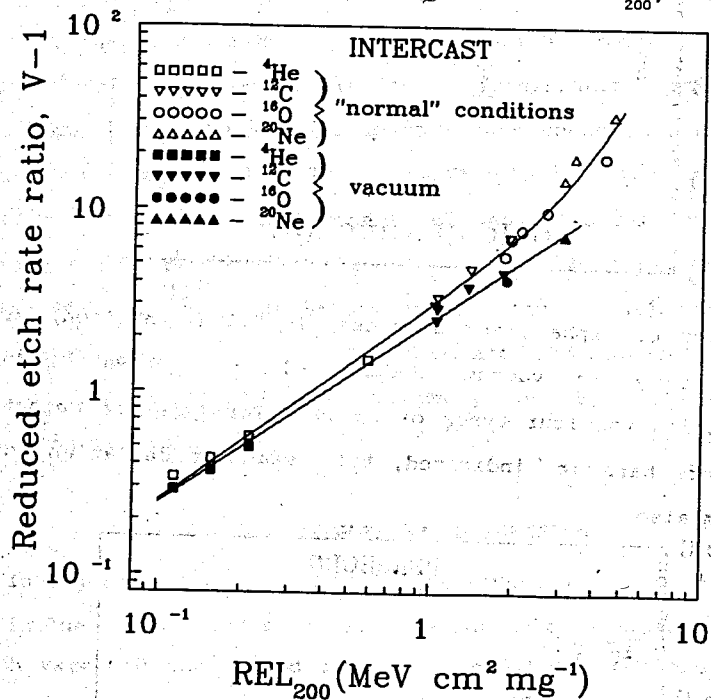


Fig.3. Reduced etch rate ratio, $V-1$, in CR-39 of Intercast Company versus REL_{200} at irradiation in "normal" (holdup time in vacuum was about 20 min) and vacuum conditions ($P \approx 2 \cdot 10^{-2}$ Pa). Holdup time in vacuum chamber before irradiation was 11.5, 20, 9 and 24.5 hours for ^4He , ^{12}C , ^{16}O and ^{20}Ne , respectively. The experimental data were best fitted by the following functions: $V=1+2.44 \cdot REL_{200}$ for vacuum and $V=1+2.955 \cdot REL_{200}^{1.068} + 0.047 \cdot REL_{200}^{3.731}$ for "normal" conditions.

polymer of Intercast Company to vacuum effect are presented. One can see, that at a small REL_{200} values ($< 1 \text{ MeV} \cdot \text{cm}^2 \cdot \text{mg}^{-1}$) the detector sensitivity practically is not changed. At more high values of REL_{200} a tendency to its decrease is observed. Nevertheless, additional verification of these data is necessary as the same $V-1$ values were obtained at different time of samples holding in vacuum (see caption of Figure 3). A similar behaviour of the MA-ND/p detector of MOM producer, was observed at residual pressure of 10^{-1} Pa for REL interval from $0.23 \text{ MeV} \cdot \text{cm}^2 \cdot \text{mg}^{-1}$ to $0.40 \text{ MeV} \cdot \text{cm}^2 \cdot \text{mg}^{-1}$ and time of detector outgassing 4h. (Csige et al., 1990). At more high REL values the sensitivity was being decreased 2,5 times. The investigated CR-39 of Intercast Company has a more wide range by REL values in which the detector sensitivity is not practically changed at the given vacuum conditions.

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