COLLECTIVE FIELD ACCELERATION OF HEAVY IONS BY REB

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In recent years, much interest has been shown in the possibility of using the collective field of intense relativistic electron beam (REB) in order to accelerate ions to high energies. The acceleration of ions in vacuum diode, where the positive ions are provided by an anode or cathode material, was first reported by Korop[1,2]. This method will make it possible to obtain the accelerated heavy ions such as uranium. Now the carefull study of acceleration mechanism is the significant requirement for realization of collective field accelerator in large scale.

The experimental configuration is shown in Fig.1. The Nano-Rad-V Electron Accelerator (0.6 MeV, 35 nsec, 4.8 kA) consists of a Marx generator, a coaxial transmission line and a field emission diode. The Marx generator, having 20 stages of capacitor and 10 spark gap switches, is designed in a coaxial geometry in order to reduce a circuit inductance caused by a misarrangement of electric parts. The output of the Marx generator is applied through the transmission line to the diode consisting of a conical and pointed cathode and a plane anode. A plane disc of stainless steel with a hole of diameter 0.5 cm in the center is used as the anode. The mass composition and energy of the beam ions which are accelerated through the anode towards the electron beam direction are detected using a Thomson-parabola mass spectrometer. The beam of ions collimated with two slits were recorded on a track detector after deflecting in the fields of the mass spectrometer, in Fig.2.

In the present experiments, a characteristic feature of the beam composition is large relative content of ions with high charge multiplicity up to 12 times. The maximum energies of the accelerated ions are found to be 10 MeV for every charge state (F_e^{+1},...,F_e^{+12}) and exceed the energy of electron beam by a factor

of 20. The ion energy spectrum for several shots usually shows ions with a small energy spread within 2 MeV. To obtain the flux density of the ions accelerated at different angles to the axis, the density distribution of etch-pits (Fig.3) were observed. The results show that the total number of accelerated ions are estimated to be 10^{9}-10^{10} per one shot and that the ion flux at the angle of 10° decreases extremely.

The electron beam emitted from the pointed cathode passes through a dense plasma[3] including highly charged high-Z ions and the beam propagates into a drift tube after passing through the anode-hole. If a slow space-charge wave is amplified as a result of the electron beam interacting with the plasma, highly charged ions will be accelerated. From the present experiments the phase velocity of the slow space-charge wave was estimated to be a order of the maximum velocity of accelerated ions.

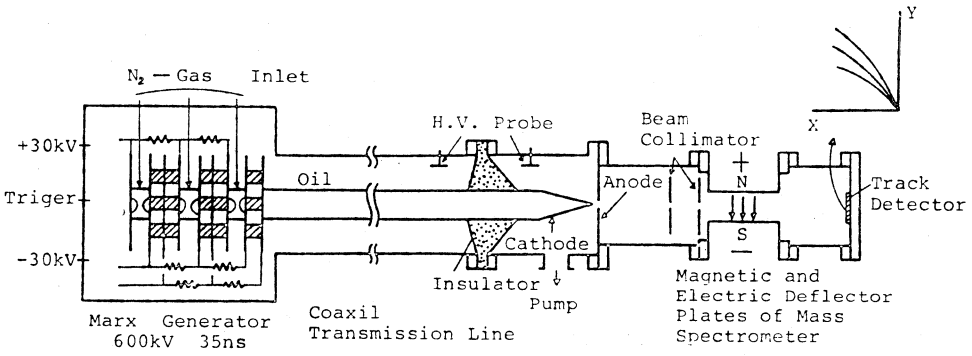

Fig.1. Schematic diagram of experimental arrangement.

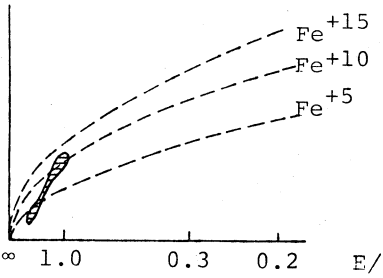

Fig.2. Experimental results on track detector with mass spectrometer.

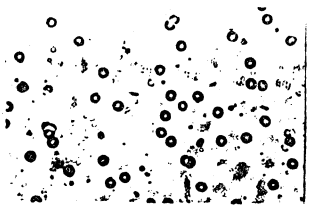

Fig.3. Photomicrograph of etch-pits on track detector.

Refferences

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3. T.N.Lee & R.C.Elton, Phys. Rev. 3, 865 (1971).