

Object: Outgassing measurements of ferrite magnets (part II)

From: M. Bernardini, C. Bradaschia, H. B. Pan, A. Pasqualetti, R. Poggiani, Z. Zhang

In this note we briefly report the results obtained on the ferrite magnets used on the magnetic antispring cleaned using ultrasonic bath in alcohol and subsequent baking in alternative to the methods described in the note VACPISA 046. The test apparatus and the measurement method are described in detail in the note VACPISA 025.

1 - System performances

After baking the base pressure of the chamber is of the order of 10^{-9} mbar and the outgassing rate of the order of 10^{-11} mbar $l s^{-1} cm^{-2}$. The main components of outgassing are H_2 , H_2O , N_2/CO , CO_2 .

2 - Measurement of the outgassing flow of ferrite magnets

The samples were ferrite magnets (brick shape, 60mmx20mmx15mm) type Ferroxdure 330 produced by Philips. We cleaned the magnets with isopropyl alcohol in ultrasonic bath and following baking at 100 °C in air for 48 hours. The exposed surface was 336 cm². We monitored the evolution of outgassing (time is measured from beginning of the test through the whole paper):

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
0.25	33	4.4×10^{-5}	4.3×10^{-4}	7.7×10^{-3}
15	32	1.7×10^{-5}	5.1×10^{-6}	4.4×10^{-4}
15.5	33	8.4×10^{-6}	3.6×10^{-6}	9.6×10^{-5}
18.5	33	4.6×10^{-6}	2.0×10^{-6}	5.2×10^{-5}
19	32	3.4×10^{-6}	7.3×10^{-7}	5.3×10^{-5}
21	32	2.3×10^{-6}	1.2×10^{-7}	4.4×10^{-5}
90.5	30	7.6×10^{-7}	4.0×10^{-8}	1.4×10^{-5}

96	30	4.7×10^{-7}	3.1×10^{-8}	8.8×10^{-6}
114	30	2.0×10^{-7}	1.6×10^{-8}	3.7×10^{-6}
141	30	6.7×10^{-8}	6.0×10^{-9}	1.2×10^{-6}

A spectrum taken at the beginning of pumping showed organic contamination (Fig. 1). The organic contamination is strongly decreased after 141 hours, but it is still present (Fig. 2). We believe that it is due to the isopropyl alcohol which has been absorbed by the samples and which has not been removed despite the prolonged baking.

We set temperature at 50 °C for 50 hours and monitored the evolution of outgassing:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
141.5	50	2.2×10^{-6}	8.8×10^{-8}	4.2×10^{-5}
143	50	2.4×10^{-6}	9.0×10^{-8}	4.6×10^{-5}
162	50	7.1×10^{-7}	4.1×10^{-8}	1.3×10^{-5}
166	50	6.3×10^{-7}	6.4×10^{-8}	1.2×10^{-5}
190	50	3.0×10^{-7}	2.6×10^{-8}	5.5×10^{-6}

The spectrum taken after 143 hours is reported in Fig. 3. There is organic contamination; the contribution of higher mass fragments contribution was strongly decreased after 50 hours of heating, but still there were some light fragments (Fig. 4).

We set temperature at 100 °C for 70 hours and monitored the evolution of outgassing:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
191	100	1.6×10^{-5}	4.7×10^{-7}	3.1×10^{-4}
261.5	100	6.8×10^{-8}	2.9×10^{-8}	6.8×10^{-7}

We observed a situation similar to the one at 50 °C. The spectrum taken after 191 hours (Fig. 5) had a stronger contamination at high masses with respect to the one measured after 261.5 hours (Fig. 6).

We set temperature at 150 °C for 47 hours and monitored the evolution of outgassing:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
262.5	150	1.8×10^{-6}	2.3×10^{-7}	3.1×10^{-5}
264.5	150	4.7×10^{-6}	2.9×10^{-6}	3.6×10^{-5}
286.5	150	1.4×10^{-6}	2.5×10^{-6}	3.0×10^{-5}
309	150	8.3×10^{-7}	1.4×10^{-6}	1.1×10^{-5}

A spectrum measured during the baking is shown in Fig. 7.

We switched off heating, and we measured:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
310	86	1.3×10^{-7}	2.4×10^{-7}	2.2×10^{-6}

312	65	2.9×10^{-8}	4.6×10^{-8}	3.4×10^{-7}
328	31	1.5×10^{-9}	5.4×10^{-10}	1.9×10^{-8}
334	31	2.3×10^{-9}	8.3×10^{-10}	2.9×10^{-8}
358	31	1.5×10^{-9}	5.4×10^{-10}	1.9×10^{-8}
429.5	30	1.3×10^{-9}	4.8×10^{-10}	1.6×10^{-8}

The spectrum measured at the end of the test is shown in Fig. 8. The outgassing rate evolution is summarized in Fig. 9.

3 - Discussion

We have measured the outgassing of ferrite magnets cleaned with alcohol and baked. The relevant outgassing rates are summarized here:

- before baking, 141 hours pumping : 3.6×10^{-9} mbar l s⁻¹ cm⁻²
- after baking at 150 °C : 4.8×10^{-11} mbar l s⁻¹ cm⁻²

The rates are lower than the ones measured in VACPISA 046 for simply baked ferrites despite the fact that the room temperature was higher for the present test. The main results of the measurement are similar to the ones of VACPISA 046. It is however better to use simply baked ferrites to avoid solvent emission at beginning and especially during warming up. On the other hand, at higher temperatures and especially in case of baking, there is a strong emission of hydrocarbon fragments. If ferrite magnets are to be used without being sealed, they should not be baked in situ. It should however be considered the possibility to encapsulate them as often performed in accelerator applications. The ferrite magnets continue to be temporarily approved, in the sense that at the moment there is not yet a better alternative.

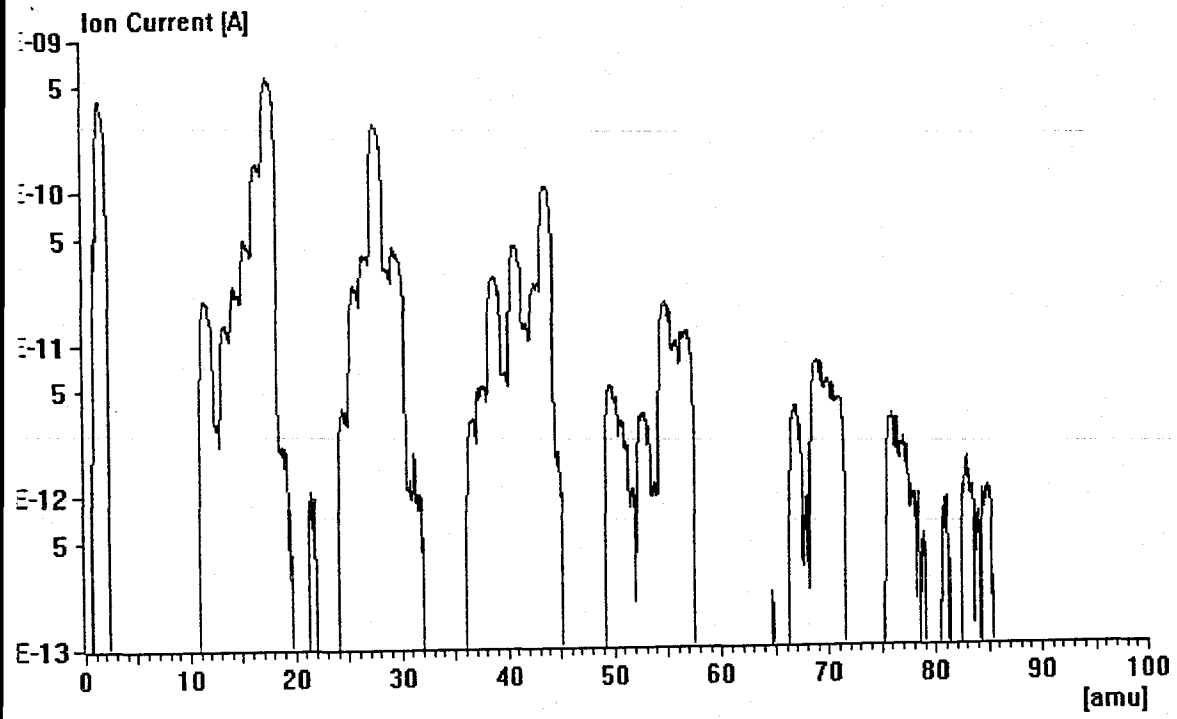
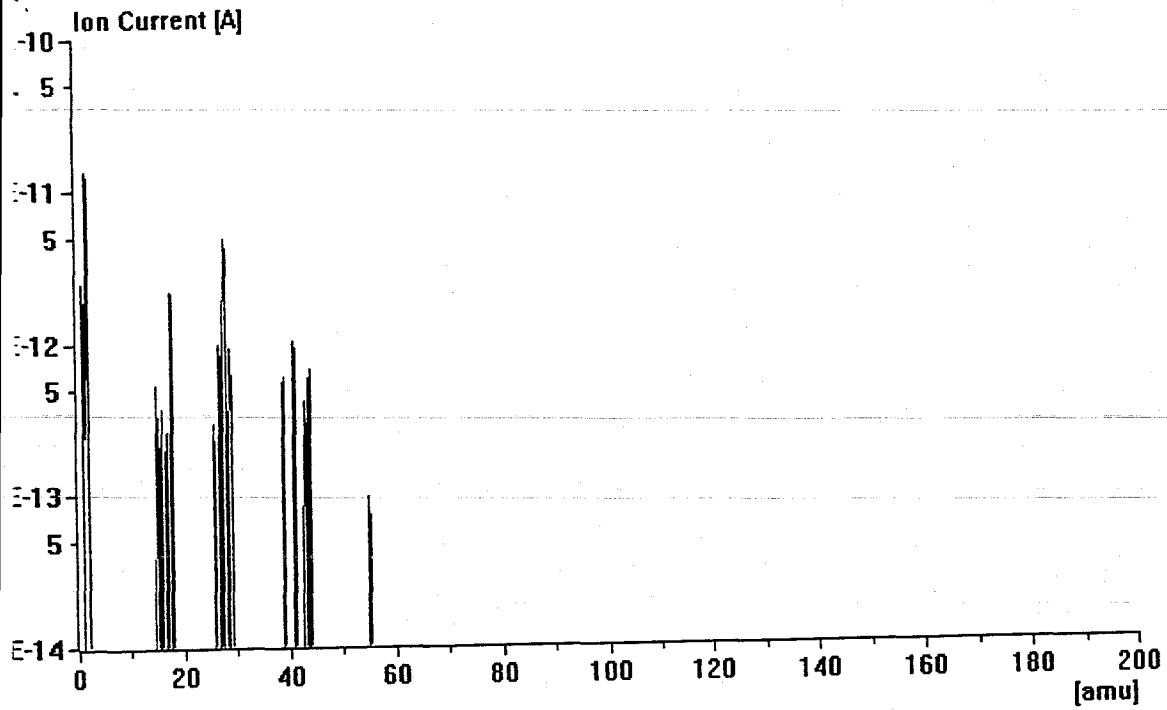


Fig. 1



X: 122.66 Y: 2.923065E-11

Fig. 2

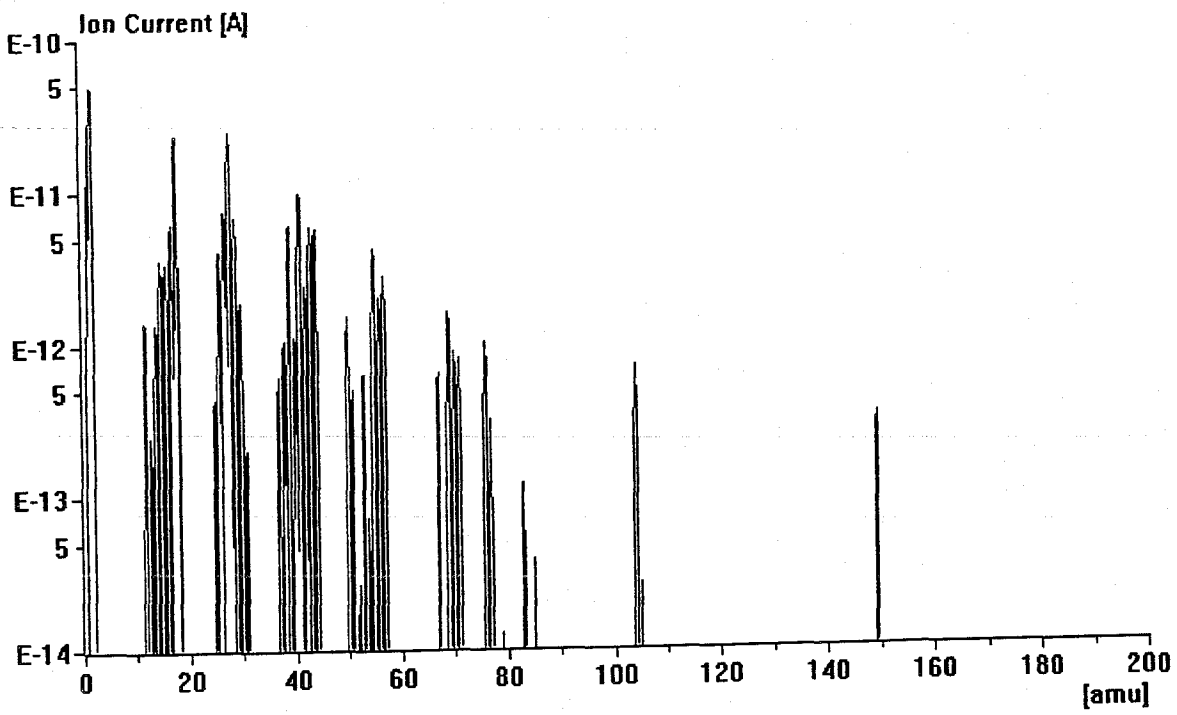
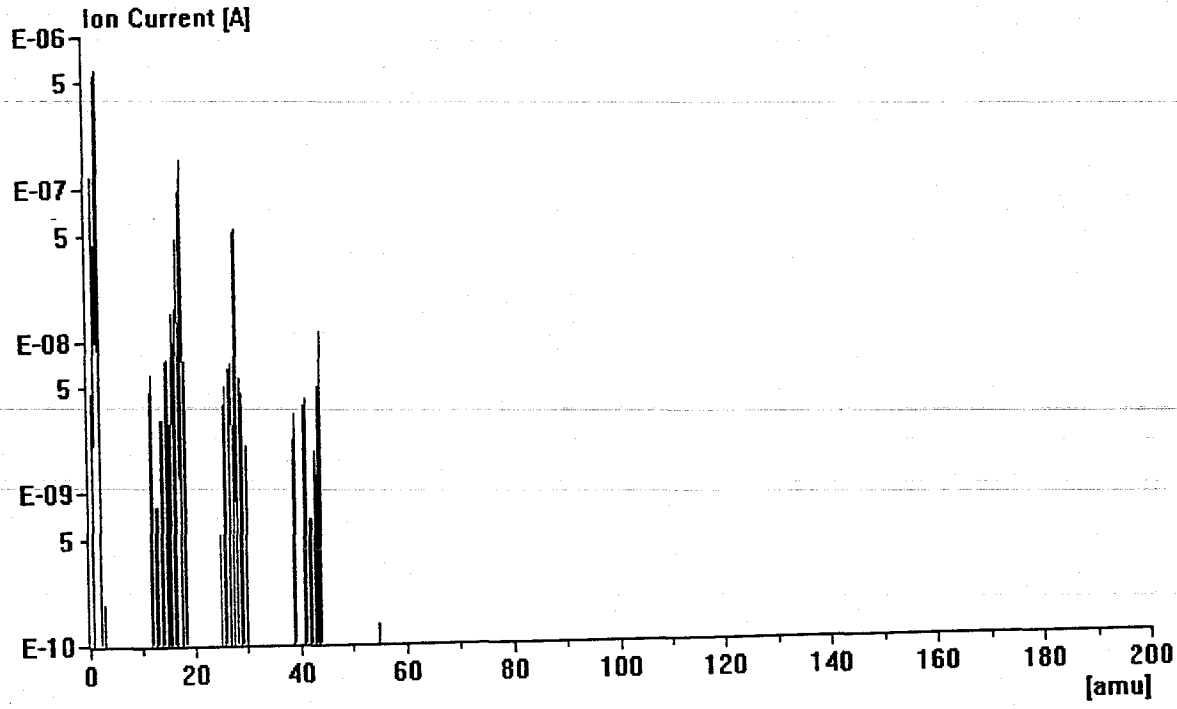
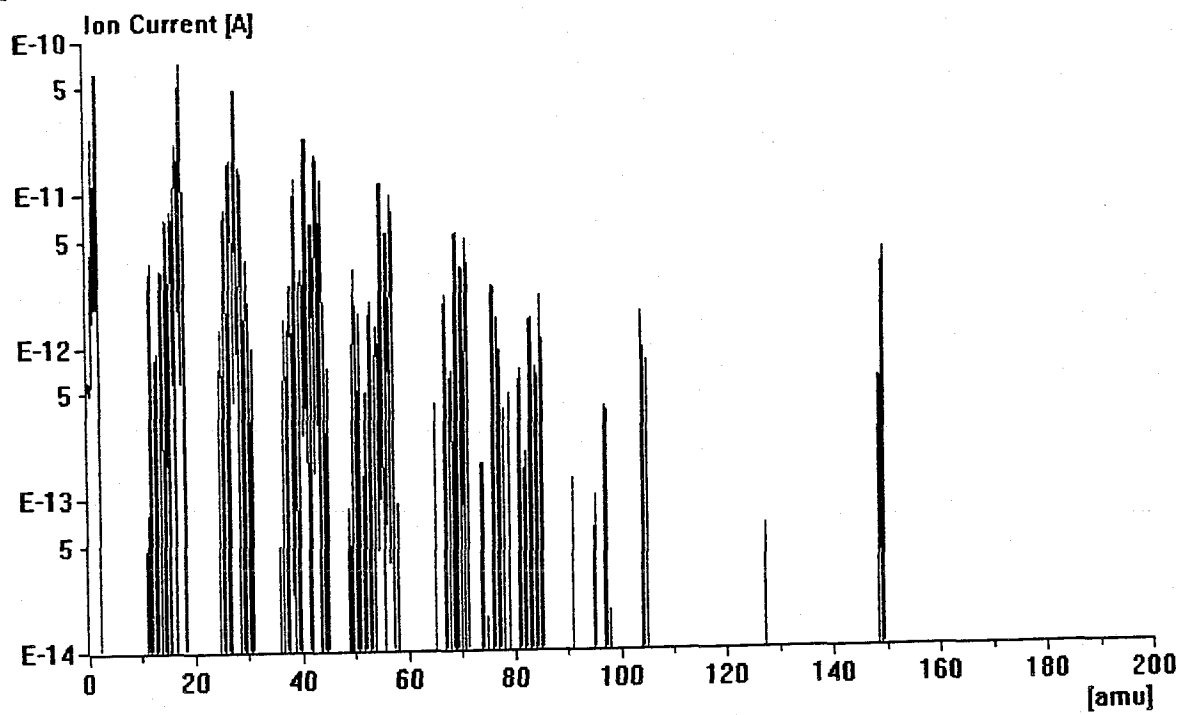


Fig. 3



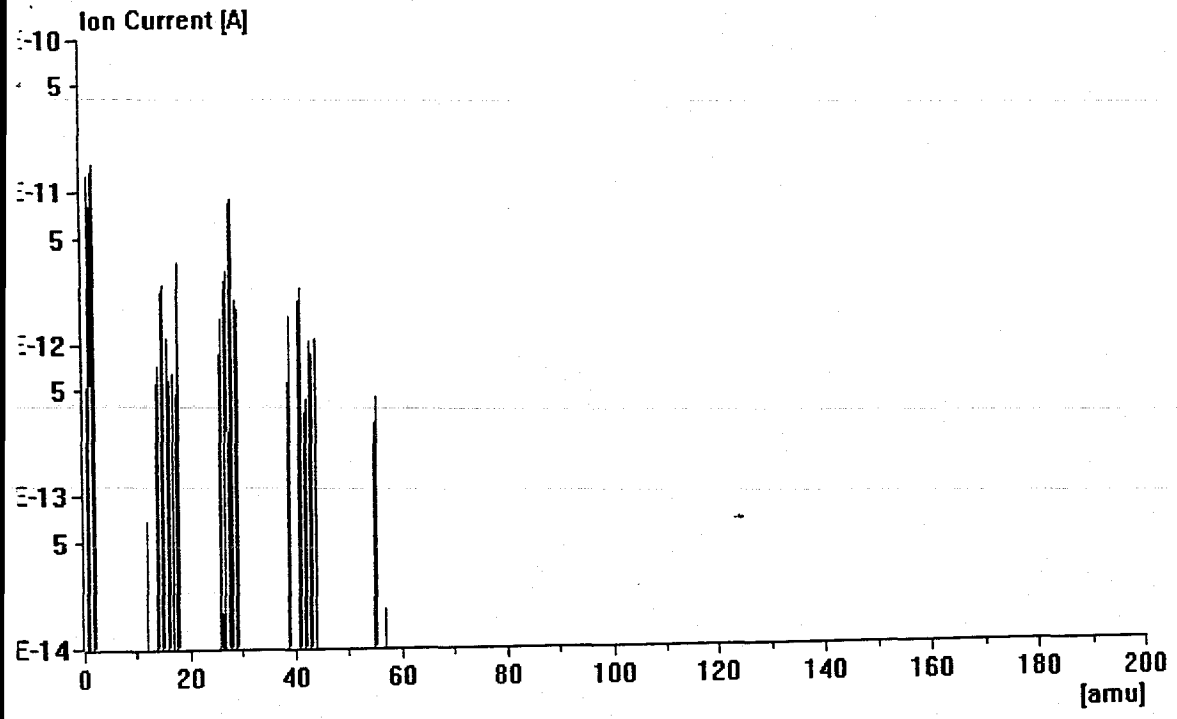
X: 60.81 Y: 8.185467E-07

Fig. 4



X: 178.91 Y: 1.014405E-13

Fig. 5



X: 66.78 Y: 5.033422E-11

Fig. 6

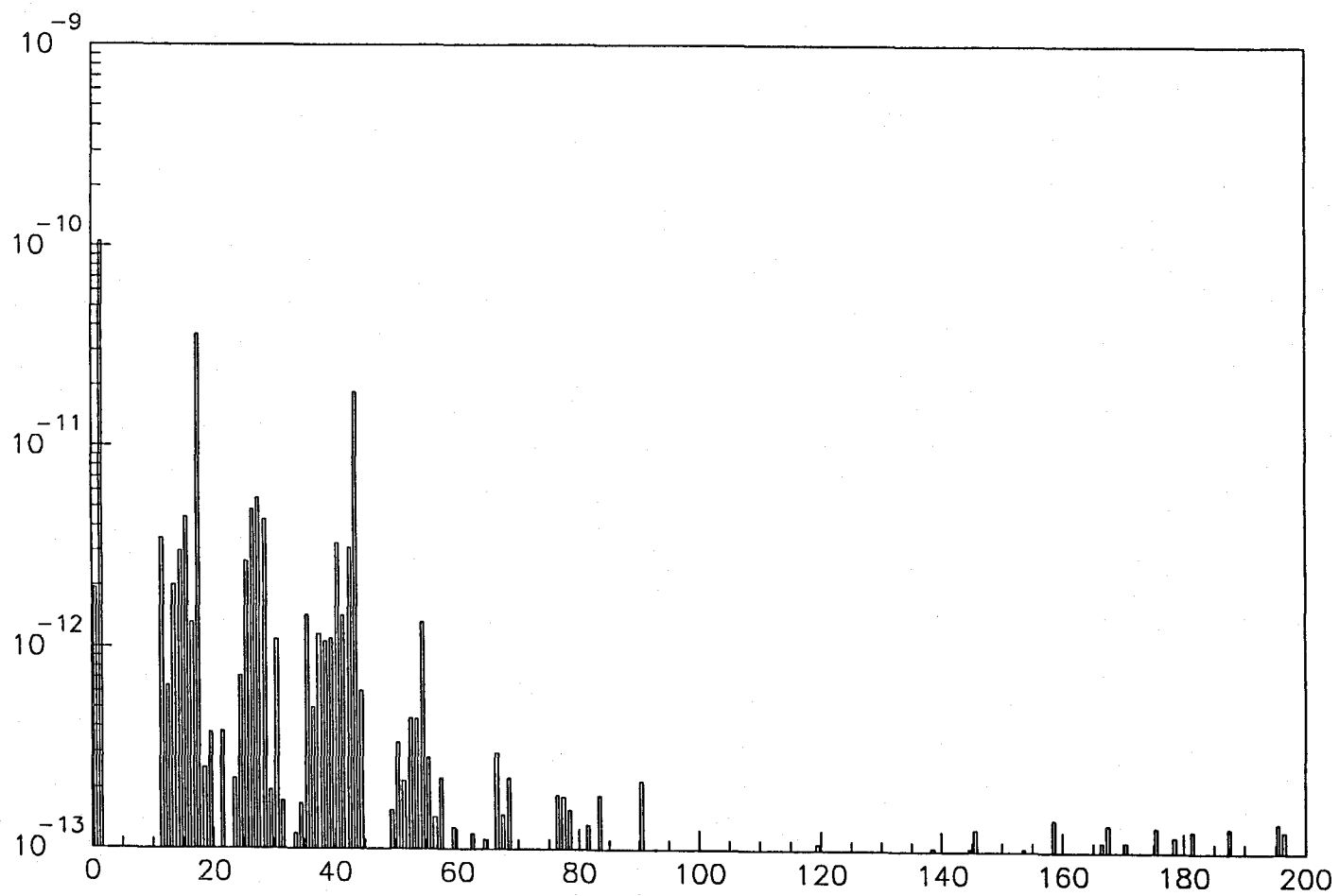


Fig. 7

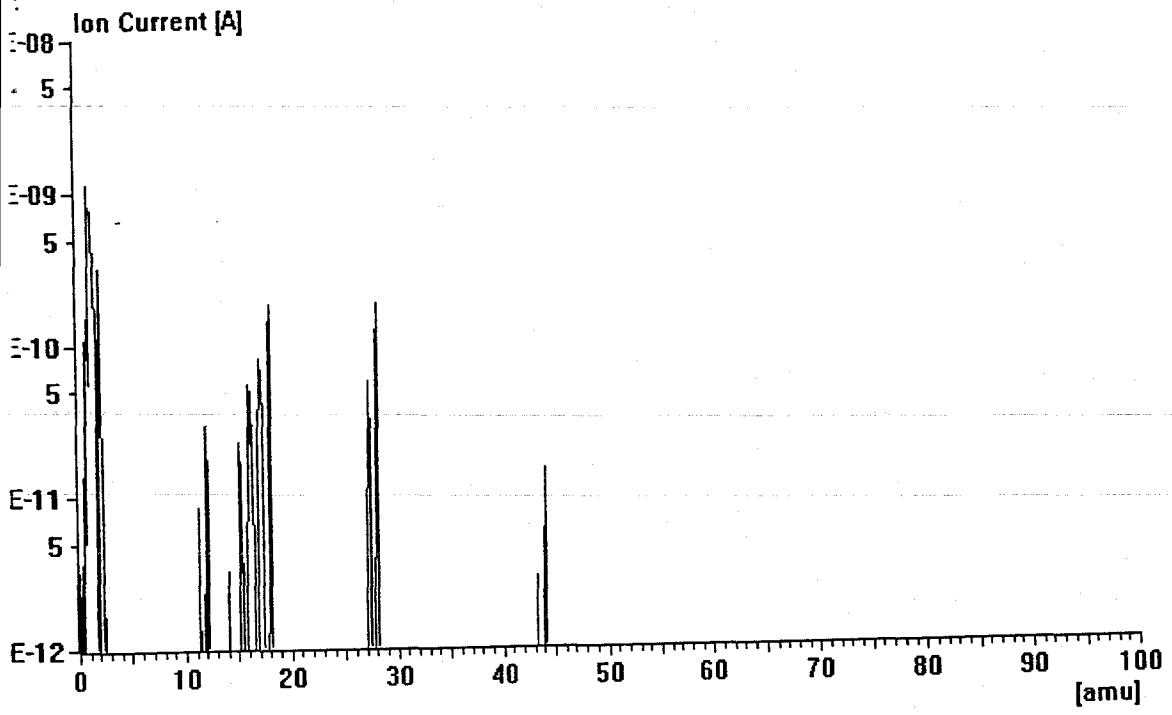


Fig. 8

Sheet1 Chart 1

