INDUSTRIAL APPLICATIONS OF HEAVY ION BEAMS AT GANIL

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Introduction

During the last year and after the GANIL shut down for increasing the heavy ion energies (O.A.E.), industrial irradiations have re-started for the production of microporous membranes (BIOPORE) and for the studies of damages induced in electronic components by differents ions (MATRA).

Some other applications have been tested.

Beam line development for industrial applications

For most of the industrial applications, but specially for the production of microporous membranes, stability and reproductibility of the beam parameters are the keys of success. As the irradiation cost is a non negligible part of the total price of products, the irradiation efficiency must be also as high as possible.

With the membrane production and the irradiation of electronic components we have the two extreme ranges of beam parameters :

- For the membrane irradiation the ion energy is less than 10 MeV/A and we use only the cyclotrons CO + SCC1. Xénon, Argon and mainly Krypton are delivered with an intensity varying around $1.5.10^{12}$pps. The vertical (40 mm) and horizontal (500 mm) sweeped beam width must be very homogenous (± 5%).

The beam stability is extremely important to produce membranes over kilometers, with a constant porosity.

For the irradiation of electronic components various ions must be used on the same products (C, O, Ar, Kr, Xe) with variable energies between 5 to 45 MeV/A. Using the same vertical and horizontal beam width, the intensity has to be as low as 10^4 pps.

Both irradiations are done in air and for each type of irradiation we have developed specific measurements and control systems as following :

- Secondary emission multi-wire profiles systems under vacuum (maximum beam intensity of the order of 100 nAe). (figures 1 - 2).
- Circulating gas multi-wire profils in air with plastic window (beam intensity less than 1 nAe) (figure 3).
- Non destructive beam transformers.

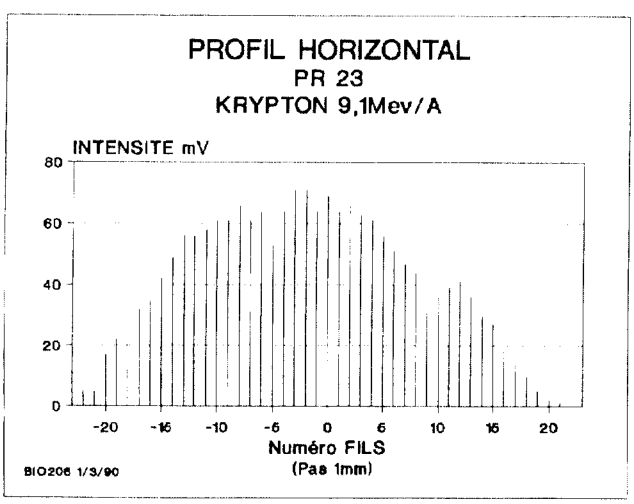

Figure 1

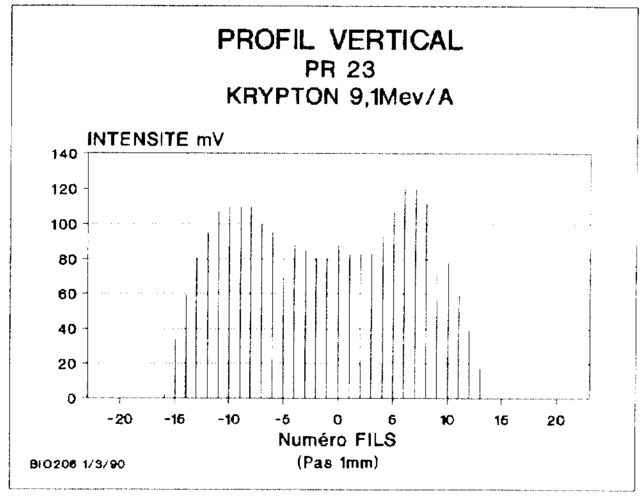

Figure 2

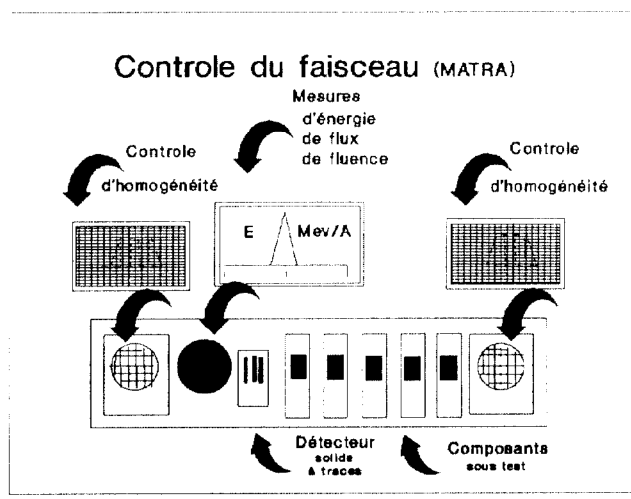

Figure 3

All these equipments are associated with a computer to control the beam stability on line.

Some other equipments have been improved :

- Higher frequencies for the horizontal (saw-tooth) and vertical sweeping magnets which give a better longitudinal and transverse homogeneity on the film.
- Low ion flux and beam energy measurements.

Main features of the microporous membranes

The main characteristics of the membrane irradiated at GANIL is the low width of the pore diameter distribution, even with large material thickness (20 to 40 μm) compared to deep membranes or others [1].

On these following figures, comparative tests are done on the flow rate (figure 4), the cumulative pore size distribution (figure 5) and the differential pore size distribution (figure 6).

On each curve we can see the advanages of this type of membrane.

Various materials can be used like polycarbonate, PET and the pore sizes can varie from 0.05 μm to few microns with nominal porosities in the range of 20%.

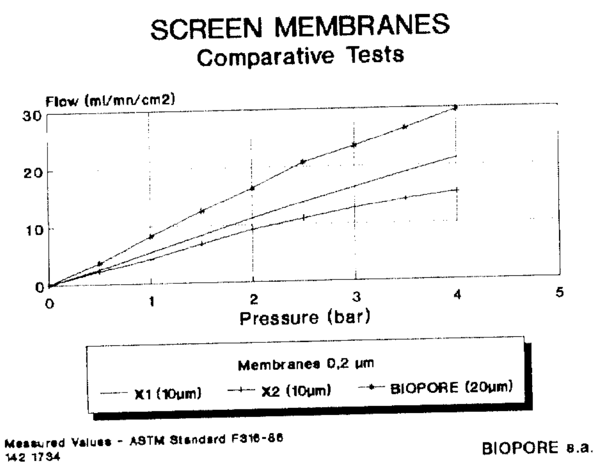

Figure 4

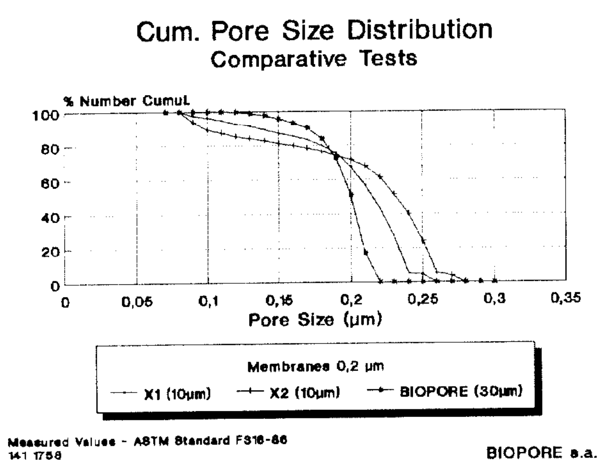

Figure 5

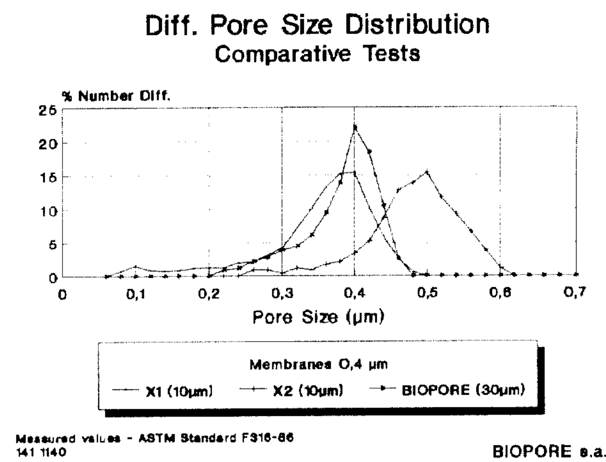

Figure 6

Electronic components irradiation

The number of errors in the components is recorded during the irradiation at various ions and energies (variable LET from 10 to 110 MeV/mg/cm^2) [2] and for a given fluence. Sigma is the ratio of this two numbers.

A comparison with the Berkeley test is given (figure 7).

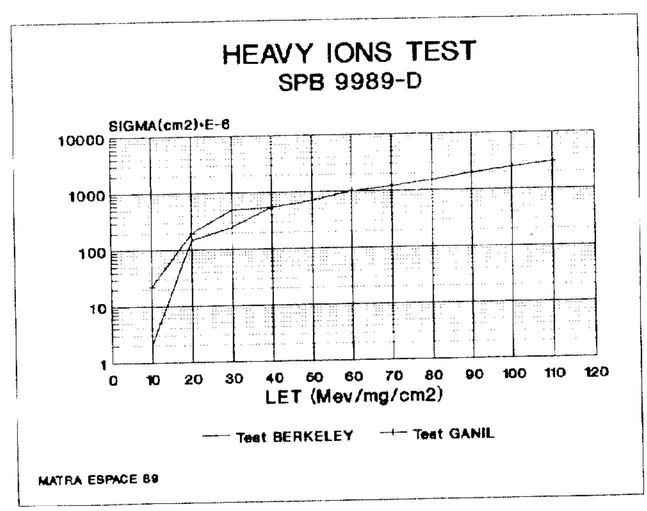

Figure 7

New developments

The research and development program is mainly devoted to other applications of micropore membranes in various field like packaging fresh fruits, vegetables, cheeses ...

We are also studying adhesion of multi-layers by two technics :

- micro solders obtained by ion bombardment with a range adjusted at the materials junction,
- pre-treatment of one material by creation of oriented pores and then evaporation (or gluing) the second material.

The use of MeV beam (total energy) coming from the future high voltage platform (100 kV) is presently under studies for ion implantation and surface treatment.

References

[1] - Thèse de Doctorat : Révélation chimique de traces latentes dans du polycarbonate. Application aux membranes microporeuses. D. BUSARDO - Juillet 1989

[2] - Caractérisation de composants électroniques aux ions lourds dans l'air - M.C. CALVET (MATRA ESPACE), C. BIETH (GANIL) - RADECS 89. Annales de Physique - Vol. Dec.89.