INFLUENCE OF CONDUCTIVITY OF THIN GOLD FILMS ON PROPORTIONAL COUNTING

L. P. MOURA and W. C. PARKER

PUBLICAÇÃO IEA N.º 369
Janeiro — 1975

INSTITUTO DE ENERGIA ATÔMICA
Caixa Postal 11049 (Pinheiros)
CIDADE UNIVERSITARIA "ARMANDO DE SALLES OLIVEIRA"
SÃO PAULO — BRASIL

INFLUENCE OF CONDUCTIVITY OF THIN GOLD FILMS ON PROPORTIONAL COUNTING

L. P. Moura and W. C Parker

Coordenadoria de Física Nuclear
Instituto de Energia Atômica
São Paulo - Brasil

Publicação IEA Nº 369
Janeiro - 1975

INFLUENCE OF CONDUCTIVITY OF THIN GOLD FILMS ON PROPORTIONAL COUNTING

L. P. Moura and W. C. Parker

ABSTRACT

In the absolute standardization of radionuclides by means of a 4π gas flow proportional counting it is common practice to deposite the radioactive material on thin foil of VYNS metalized with gold to render it a conducting surface. ~~In the present work~~ The detection efficiency as well as the pulse time formation distribution in function of the conductivity of these foils were measured. With these it was verified that the conductivity has ~~a~~ significant effect on the detector field configuration and the most convenient conductivity value that must be used ~~was determined~~

In the absolute standardization of radionuclides by means of 4π gas flow proportional counting[1] it is common practice to deposit the radioactive material on a thin foil (backing) of organic material usually in the form of VYNS, a co polymer of polyvinyl chloride and polyvinyl acetate[2]. However, since VYNS is a dielectric it is first necessary to metalize the foil's surface so as to render it conducting. The activity can then be deposited by one of the methods described in the litterature[3][4]. The importance of this conducting layer can not be overemphasized since a non conducting, or poorly conducting surface, can cause serious deviations in the configuration of the counter's electric field. On the other hand a too thick layer will result in the absorption of the low energy components. Thus it becomes desirable to determine the optimum thickness/conductivity value for the metal layer.

Fig. 1. demonstrates the effect of the film resistance on the efficiency of the counter. Here it can be seen that by increasing the tickness of the gold film to a point where the resistance is in the region $10^6 - 10^5$ ohms, the efficiency of the counter increases, but below this value it begins to decrease due to the absorption of the low energy radiation components. A similar result can be observed for the pulse time resolution of the counter. This can be seen from the time pulse distribution[5] shown in fig 2. By correlating the gaussian analysis with each distribution and by considering the difference in area as a parameter, it can be seen in table 1, that at 10^6 ohms the best resolution occurs.

In the course of our experiments we have observed an anomalous behaviour by the gold films prepared by means of vacuum evaporation[6], that is, a spontaneous variation of the resistance the direction of which (high or low) depends on the value of the film resistance at the termination of the evaporation. This effect is clearly demonstrated in fig 3. The continuous line represents the steady decrease of the resistance during the actual condensation of the gold vapour on the substrate and the broken line the spontaneous variation following the interuption of the evaporation. As can be seen there are three different changes of direction, i.e., at 10^6 ohm the resistance almost stabilizes while above and below this value, it increases and decreases respectively.

Fig. 4., shows the results of the counter efficiency measured as a function of the

spontaneous decrease of the resistance which, in this particular case, occured at $R \sim 10^4$ ohm. It shows that while the resistance is decreasing spontaneously by one order of magnitude, the counter efficiency improves by about 6% in 24 hours due to the improving electric field, but without the increased absorption of the low energy components.

Immediately after the evaporation the decrease in resistance is more rapid. The degree of increase and the time required for exe are dependent on the conditions of the evaporation and also the crystalization of the source material. Variations of the order of 30% could still be observed several weeks from the date of the evaporation. The time pulse distribution obtained immediately after a given evaporation and a period of elapsed time also indicate an improvement in the counter's electric field.

The spontaneous changes of the electrical resistance of thin gold films coated on VYNS foils, have also been confirmed by means of the electron microscope. Those films examined showed a spontaneous and dynamic morphological behaviour in complete agreement with that of the variation of resistance.

There can be no doubt that conductivity of the conductivity of the gold film on which the radioactivity is deposited has a significant effect on the electrical field of the counter. Also, there occurs a spontaneous variation of the resistance, depending on its value, at the conclusion of the evaporation. Therefore, it would seem wise to continue with the evaporation until such time as the resistance begins to decrease spontaneously and then to wait, if possible, at least 12 hours before commensing the activity measurement in question.

TABLE 1

Time Distribution	Thickness g/Cm²	Resistance Ohms	ϵ(xe) (%)	Gauss (ns)	Normalized area of the experimental distribution minus gaussian area.
A	C	10^{14}	15	80	
B	13.35	3×10^7	24	9	1.2
C	21.64	6×10^4	27	10	1.0
D	18.06	4×10^6	29	8	1.0

This table is related to fig. 2, applying the experimental points to the gaussian it shows that the best resolution is obtained for distribution D. Increasing the gold layer to 3.6 μg/cm² lowers the resolution by about 20%. However, the number of counts in the tail of the distribution plot do not diminish.

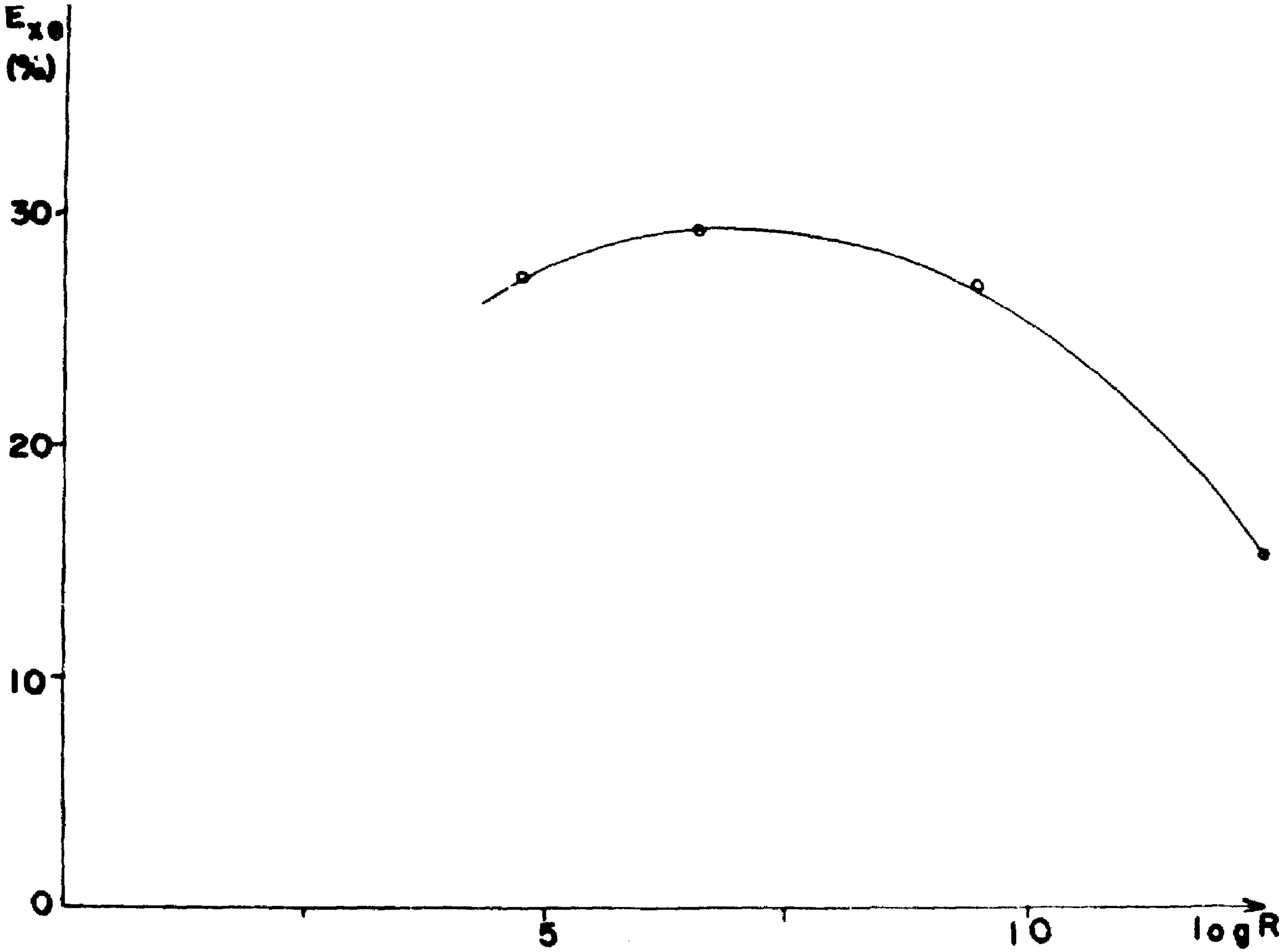

Figure 1

Efficiency of proportional counter for ^{54}Mn taken as a function of the resistance of the thin gold film.

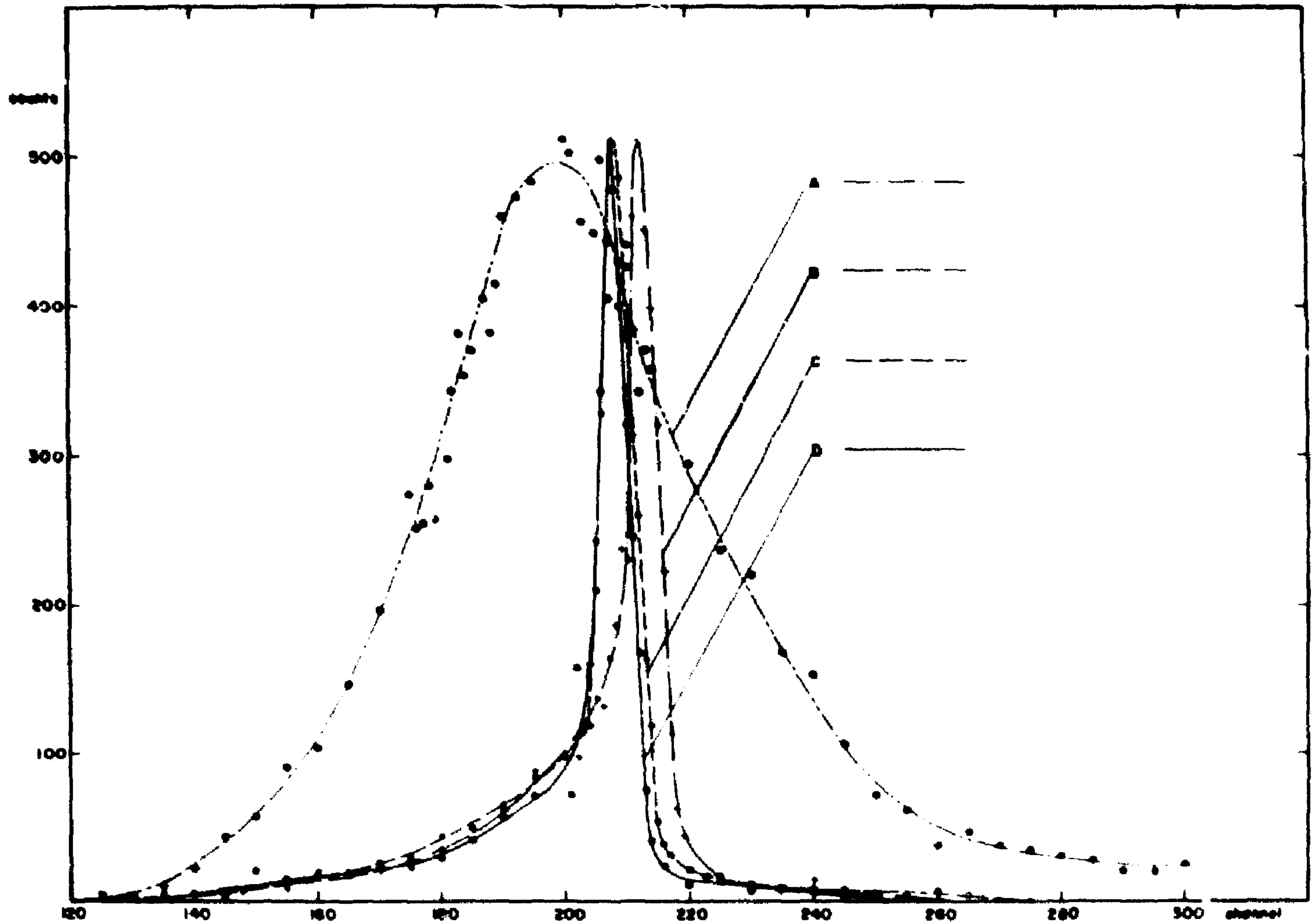

Figure 2

Distribution of pulse formation time in the proportional counter for ^{54}Mn deposited on different thicknesses of gold coated VYNS (see table 1)

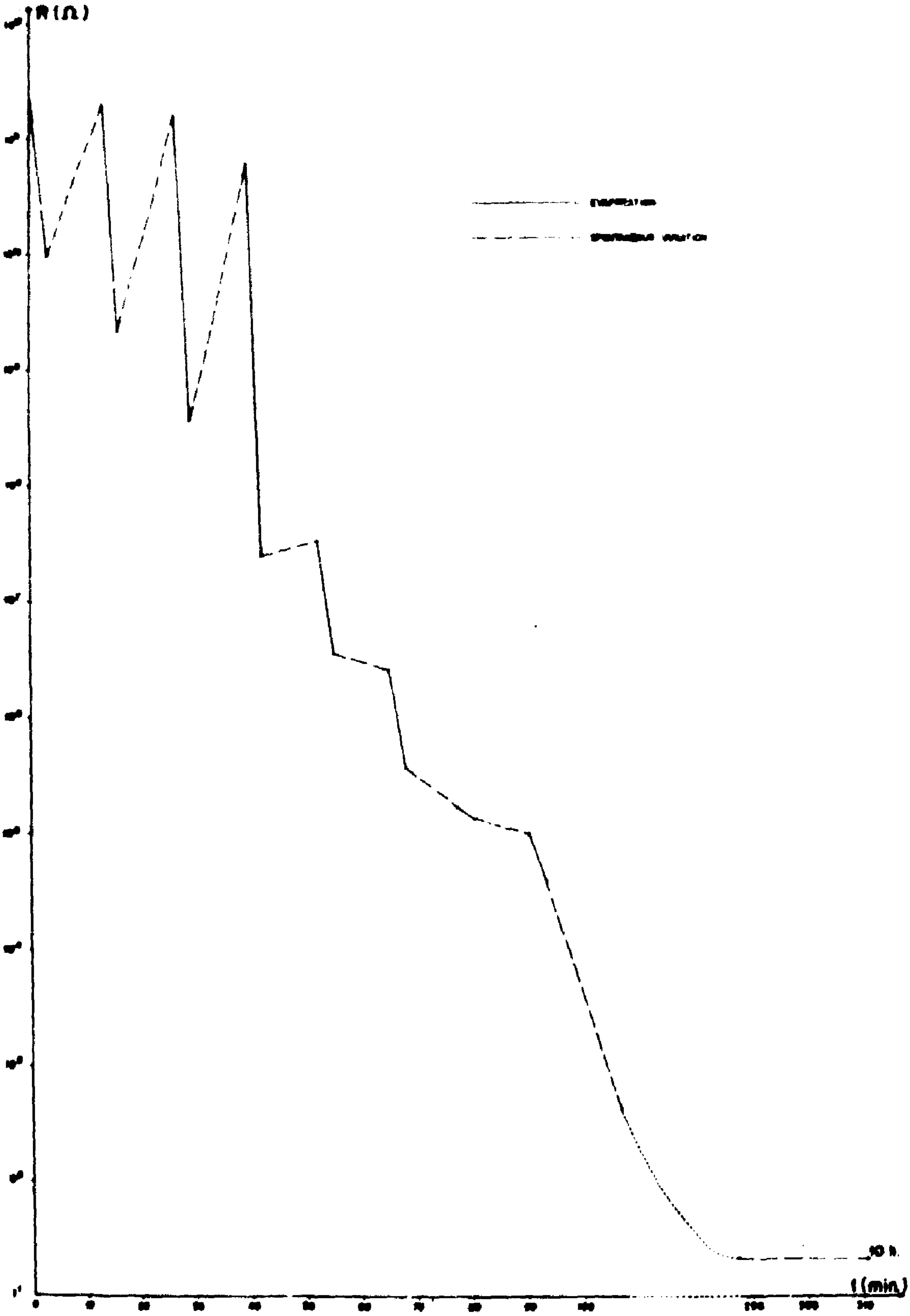

Figure 3

Consecutive 10 min. interval evaporations and the spontaneous variation of the resistance following the interuption of the evaporation. If the evaporation is terminated in the region $10^7 - 10^5$ ohms, the resistance value stabilizes.

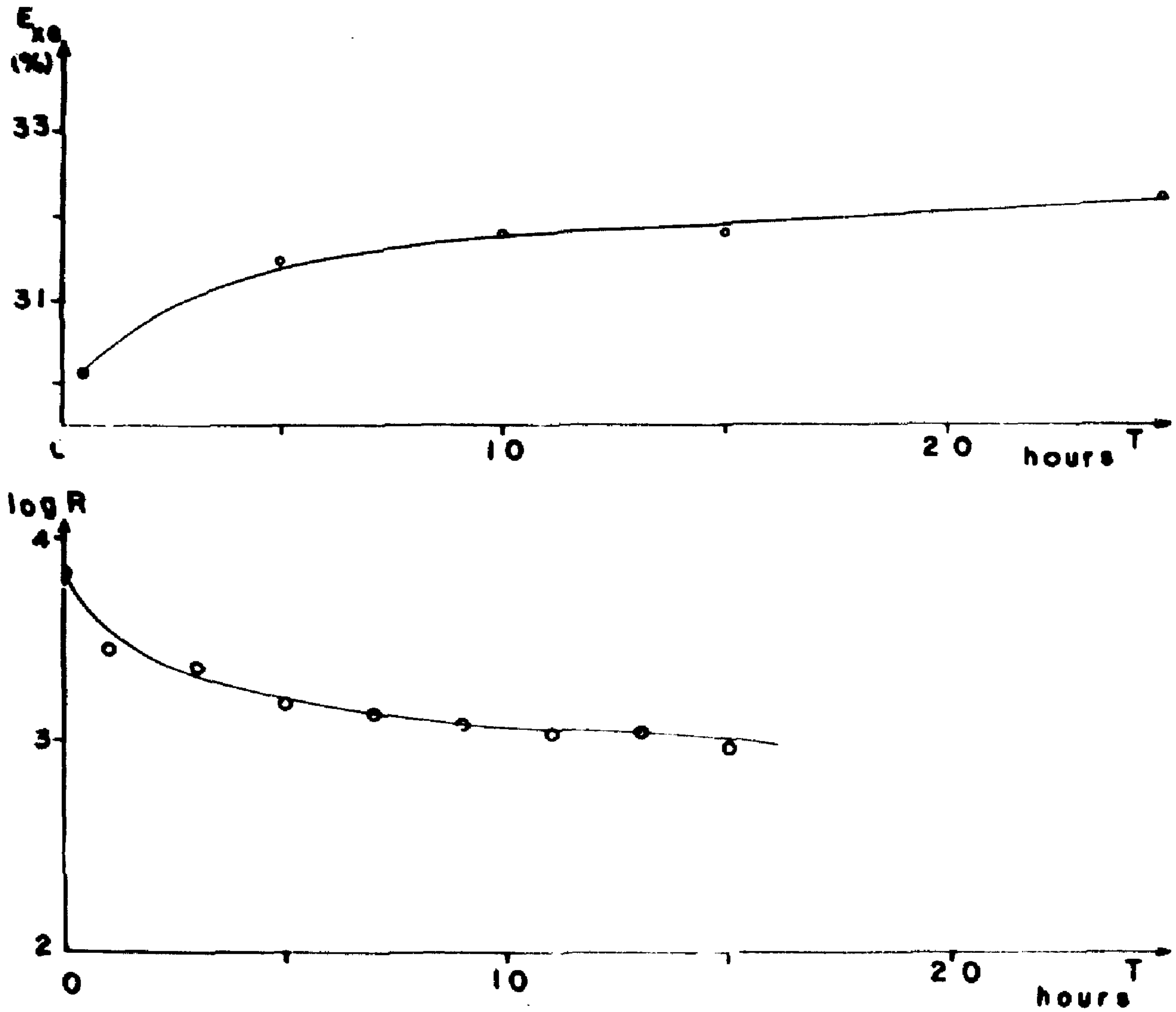

Figure 4

Spontaneous decrease of resistance of gold film accompanied by simultaneous increase of detection efficiency.

RESUME

Dans la padronization absolute des radionuclides faite pour compteur proportionnel 4 π généralement sont employés filmes minces de VYNS métallisés avec l'or comme supports pour le matériel radioactif de sort que sa superficie soit rendue conducteuse. Ce travail présent les resultats des mesures de la variation d'efficience de détection du détecteur et aussi la variation de distribution du temps de formation des pulses en function de la conductivité de ces filmes. Les resultats obtenus ont montré que la conductivité a un effet important dans la configuration du champ électrique du détecteur et on a été determiné le meilleur valeur de conductivité a être utilisé.

RESUMO

Na padronização absoluta de radionuclídeos através de contador proporcional 4π comumente são empregados como suporte do material radioativo filmes finos de VYNS metalizados com ouro para tornar a superfície condutora. Neste trabalho são apresentados os resultados das medidas de variação da eficiencia de detecção do detetor e a variação da distribuição de tempo de formação de pulso em função da condutividade desses filmes. Através desses resultados verificou-se que a condutividade tem um efeito significativo na configuração do campo elétrico do detetor e determinou-se o valor mais conveniente de condutividade que deve ser utilizado.

REFERENCES

1. Campion, P. J. Int. J. Appl. Rad. Iso. 4 (1959) 232.

2. Pate, B. D. and Yaffe, L. Can. J. Chem. 33 (1955) 15.

3. Yaffe, L. Preparation of Thin Films, Sources and Targets. in Ann. Rev. Nucl. Sci. 12 (1962) 153 - 188.

4. Parker, W. C. and Slätis, H. Sample and Window Techiniques in Alpha, Beta and Gamma-Ray Spectroscopy. Ed: K. Siegbahn. North Holland Publishing Company, Amsterdam, 1965.

5. Williams, A. and Campion, P. J. Int. J. Appl. Rad. Iso. 16 (1965) 555.

6. Moura, L. P., Pimentel, C. A. and Parker, W. C (in press)