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DOSIMETRIC PROPERTIES OF PLASTIC FILMS OF POLISH PRODUCTIONS

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DOSIMETRIC PROPERTIES OF PLASTIC FILMS OF POLISH PRODUCTION

ZASTOSOWANIE POLSKICH TWORZYW SZTUCZNYCH W DOZYMETRII PROMIENIOWANIA ELEKTRONOWEGO

ПРИМЕНЕНИЕ ПОЛЬСКИХ ПЛАСТИКОВ В ДОЗИМЕТРИИ ЭЛЕКТРОННОГО ИЗЛУЧЕНИЯ

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Abstract

Several types of Polish production films were investigated as dosimeters for electron beam irradiations. Quality of Polish and West Germany PVC-films was compared.

Streszczenie

Badano wykorzystanie kilku folii produkcji krajowej dla potrzeb dozymetrii promieniowania akceleratorowego. Przeprowadzono porównanie folii krajowych z polichlorku winylu z foliami produkcji NRF.

Резюме

Исследовались возможность применения отечественных фильмов в качестве дозиметров электронного пучка. Качество поливинилхлоридных фильмов мы сравнивались с качеством похожего фильма производства ФРГ.

The present work is a continuation of previous studies, the results of which were presented at the IAE Conference at Vienna, in April 1972 [1]. These studies were connected with the application of some plastics to γ-dosimetry. The present work clears with the application of the same materials to electron dosimetry.

The examination comprised films of three domestic plastics:

1. polyvinyl chloride
2. cellulose triacetate
3. polyethylene terephtalate.

Spectrophotometry was used as analytical technique.

Absorbance was measured in transmitted light using non-irradiated samples as reference. The absorption spectra of these films are shown in Fig.1. Foils of various radiation stability were selected for application as dosimeters. This permits to measure radiation doses within a wide dose range i.e. 0.5 - 70 Mrads. High radiation doses are necessary for treatment of inorganic materials.

The applicability of the above dosimeters is obviously not the same PVC is the most frequently used material. Hence the greatest part of this work is devoted to PVC. Films of hard PVC are used as dosimeters for the control of technological irradiations in the dose range 0.5 - 7 Mrads.

Calibration of all films irradiated in the electron beam field was carried out by means of domestic calorimeters, similar to those used at Risø. The calorimeter is a shallow box of polystyrene of dimensions 20 x 140 x 100 mm, mounted in a styrofoam envelope.

The temperature is measured by means of accurately calibrated thermistors, with an accuracy of 0.1°C.

As mentioned above, PVC was the material most extensively examined, because of its wide applicability.
Films of Polish production and imported PVC were subjected to irradiation and conditions of post-irradiation treatment were established. It was determined that the PVC film manufactured by Kunststoffwerke Staufen, of a thickness of 0.27 mm is the most suitable for dosimetry of sterilizing doses.

It follows from Fig.2, that it is of great advantage to have several types of films of the same material because this permits to select the most suitable one for a given dose range. For example for the dose range from 0.5 - 3 Mrads a film of higher sensitivity

/PVC "N"/ its the most suitable while for higher doses a film of lower sensitivity /PVC "T" or "P"/ should be used. Already in the first works [2, 3] on the application of PVC in dosimetry it has been pointed out that the colour of the irradiated films changes /intensifies/ during many days following irradiation.

All transparent PVC films behave in this way independently from their type and so the behaviour of irradiated films for dosimetric applications should be examined in details and the conditions of heat treatment should be chosen as to ensure constant absorbance of the films during storage.
Such conditions were established in the present work for all the above films. The temperature of heat treatment varies generally in the range 60 - 70°C. Higher temperatures may result in deformation of the samples.
The irradiated and heat treatment samples behave in an individualistic way and it is necessary to select proper temperature and time of heat treatment /Fig.3./.

The Polish film should be heat treatment at 70°C for 30 minutes. During the first 24 hours following heat treatment the absorbance decreases only by 10 % /Fig.3/. This is followed by a 20 days period during which the absorbance is constant. Then the absorbance increases slowly. The absorbance of the other two films does not change during the first period. First after 20 - 25 days small changes can be observed. The German film, which is the most sensitive towards radiation, has however a more disadvantageous property i.e. its absorbance depends to a high degree on the temperature of heat treatment /Fig.4/.

The other two films mentioned at the beginning are less frequently used in dosimetry, because the dose range which can be measured with their aid is above 10 Mrads. Cellulose triacetate is a polymer, which undergoes degradation upon irradiation. Radiation changes result in appearance of an absorption maximum in the UV region at λ = 288 nm.

The height of the maximum depends on the dose. Hence the polymer can be applied as dosimeter in the dose range from 6-25 Mrads. /Fig.5./.

Also the films of ethylene polyterephtalate /Estrofol/ are less frequently used in dosimetry as compared with PVC. It exhibits an absorption maximum at λ = 320 nm.

It follows from the course of the curves shown in Fig.5 that the dose range for this film is even wider and extends up to 100 Mrads.

The accuracy of the dose measurement for the two films is lower than that for PVC and amounts to ±10%.

References

1. R.K.Broszkiewicz, Z.Bułhak; Proceedings of IAEA Conference Vienna 1972, 599.
2. J.E.Maul, N.W.Holm, I.G.Draganić; Danish AEC Risø, Rep.No.31 /1961/.
3. J.Popović; Danish AEC Risø, Rep.No.141 /1966/.

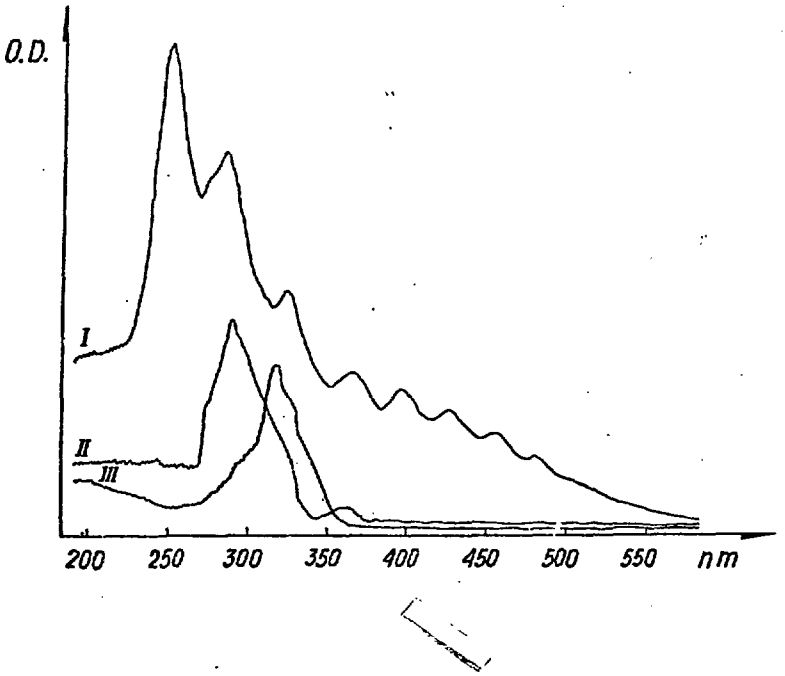

FIG. 1. Absorption spectrum of films:

1 polyvinyl chloride;
II Cellulose tricetate;
III Polyethylene terephtalate.

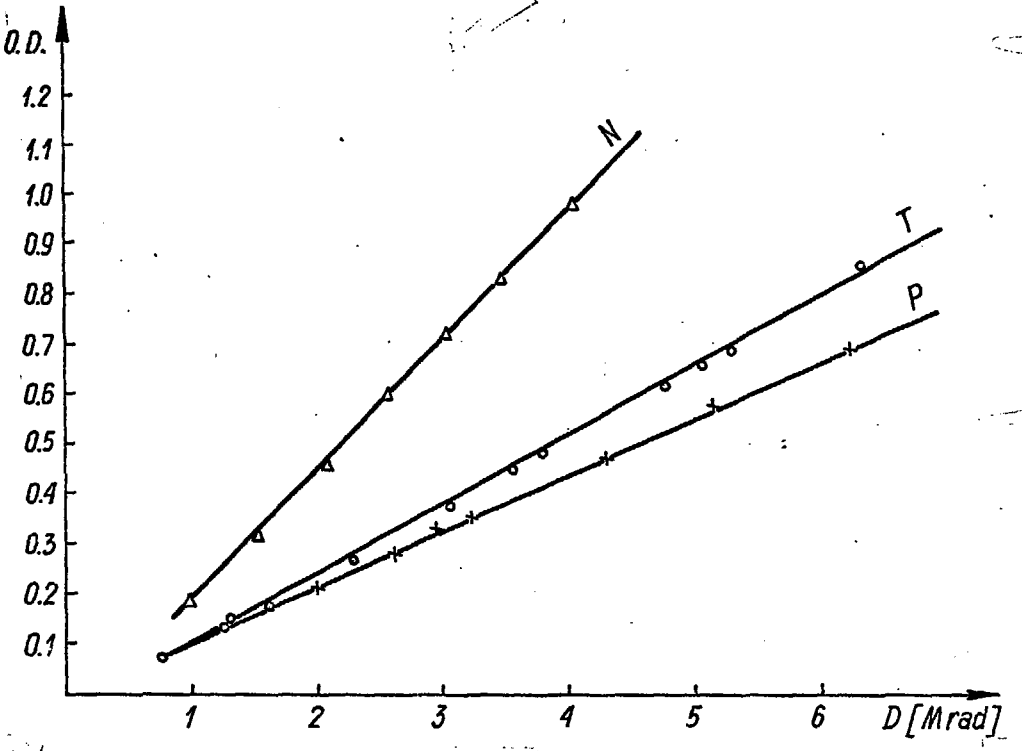

FIG. 2. Calibration curve of several types of polyvinyl chloride:

N - German production type 000,
T - German production type 001,
P - Polish production.

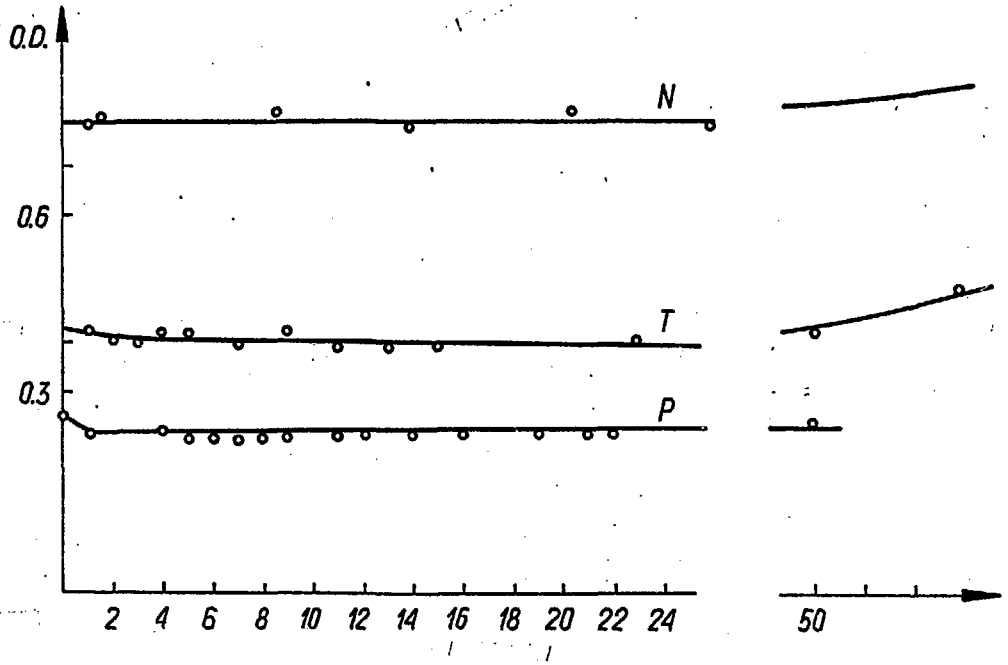

FIG. 3. Fading effect of polyvinyl chloride after heat treatment:

N - German production type 000
T - German production type 001
P - Polish production

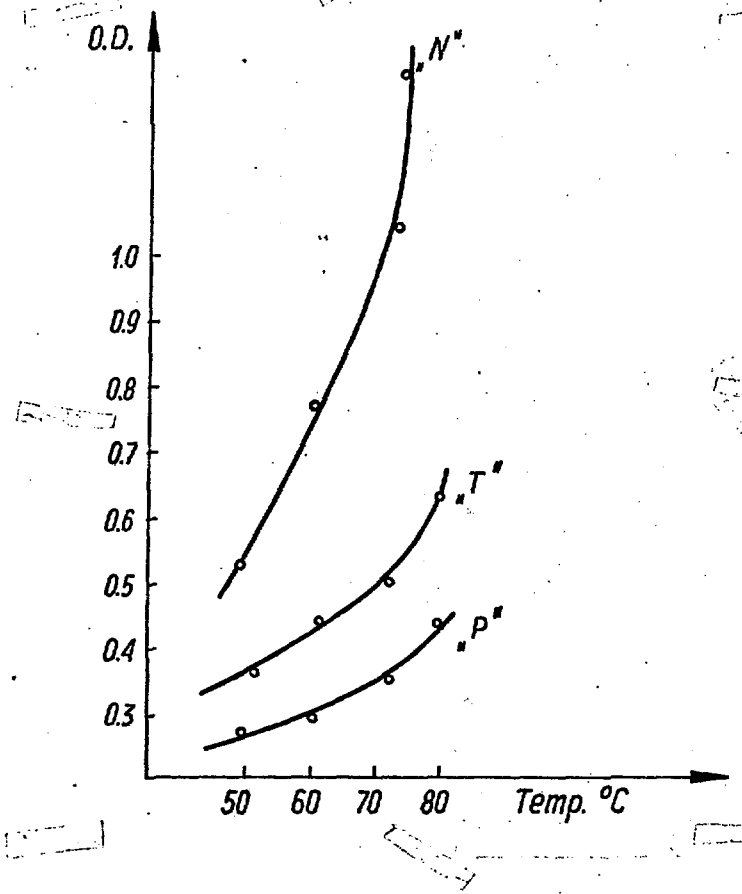

FIG. 4. Influence of heat treatment on the absorption of irradiated PVC-films.

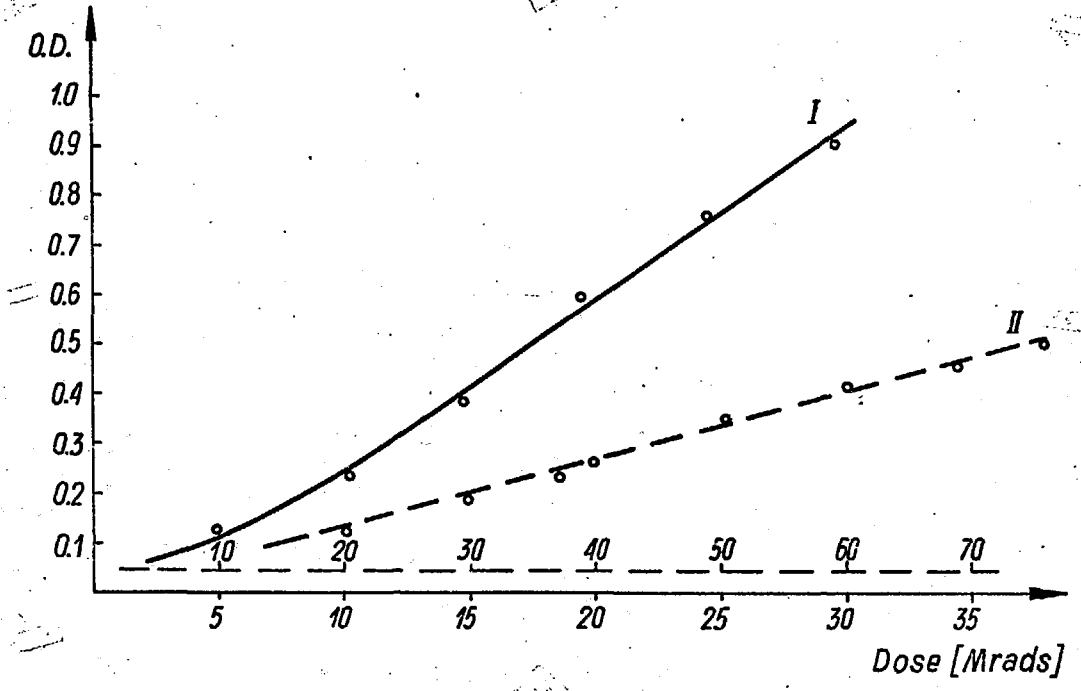

FIG. 5. Calibration curve of: I Cellulose triacetate;
II Polyethylene terephtalate.