PERSONAL MONITORING FILM

FILMS FOR PERSONAL DOSIMETRY

General information

Foma PMF is a set of two films intended for personal dosimetry of gamma radiation, x-radiation and electrons:

Foma DF10 is a high speed film double coated on a blue coloured polyethylene terephthalate base.

Foma DF2 is a low speed (emergency) film.

The films are supplied in the 3 x 4 cm size (according to ISO 3665). One package contains 150 pieces of DF10+DF2 film sets packed in light-proof and moisture-proof packing.

The films are intended for use with dosimetric film holders. Depending on the processing method they can be used for measurement of personal dose equivalents of photon radiation in the energy span from 15 keV to 6 MeV in the range from 0.1 mSv to 2 Sv.

Darkroom light

Due to their high speed, the films must be processed under indirect yellow safelight or diode lighting with a wavelength of 590 nm and higher. Length of exposure and the distance of the processed material from the illumination source should be tested.

Processing

Dosimetric Foma films can be processed using the liquid x-ray developer Foma LP-T with and rapid fixer Fomafix. Application of a mildly acidic stop bath is recommended between developing and fixing.

Film processing is performed at temperatures from 19 to 21 °C. Development time depends on developer concentration, temperature and on the intensity of solution exchange in the film vicinity. It must be determined experimentally. Typical values are between 5 and 7 minutes.

Packing

The film is supplied in the 3 x 4 cm size (according to ISO 3665). One package contains 150 pieces of two sheet moisture-proof packets from plasticized PVC.

Storage

The films should be stored at temperature up to 25°C and relative humidity not exceeding 60% outside the reach of the effects of ionising radiation and aggressive vapours. If the difference between temperature of storage and temperature of use is more than 15°C then films must be acclimated for min. 3 hours.

Dosimetric characteristics of the films and their optimisation

The basic dosimetric characteristic is the optical density versus ionising radiation dose curve of the film. As opposed to the visible radiation, this curve is linear with a dose from the lowest doses. If the films are to be used for personal dosimetry purposes, the lowest measurable dose should be approximately 0.1 mSv according to international recommendations ICRP 60 and ICRP 75. This can be achieved with the films Foma DF10 experimentally by an appropriate selection of developing conditions. The procedure is as follows. The set of personal monitoring films is exposed to gamma radiation (emitter Cs-137 or Co-60) with kerma in the air in the range from 0.1 mGy to ca. 40 mGy. These films are then developed together with films that were not exposed to the radiation (fog or background) in given equipment for a variety of time periods (approx. from 5 to 7 minutes).

The determination of the optimum development time is then based on the condition that for the high speed film DF10 the optical density of background (fog) increased by 4 σ of the background must correspond with kerma in the air lower than 0.1 mGy (read from the gamma radiation calibration curve).

Fig. 1 displays the calibration curve i.e. dependence of optical density on the ionising radiation dose for DF10 films and gamma radiation Cs-137 obtained under optimum processing performed in the National Personal Dosimetry Service (CSOD, s.r.o., Czech Republic).

The lowest measurable dose is 0.08 mSy (± 30 %) and the measurement uncertainty is better than ± 15 % for values higher than approx. 0.2 mSv. The requirements of the recommendations ICRP 60 and ICRP 75 are thus met by a considerable margin (uncertainty from -33 % to +50 % in annual dose limit). The corresponding curve for x-radiation with energy 49keV (approx. 70 kV + 0.5 mm Cu) is shown in fig. 2.

Calibration curves for emergency films Foma DF2 are shown in fig. 3 and 4 for gamma radiation and x-radiation with maximum efficiency (49 keV) respectively. These curves were obtained under developing conditions determined for high speed films Foma DF10 as optimum. It is evident from figs. 1 and 3 that the ranges of gamma radiation doses overlap with a considerable margin and the upper limit of the measuring range is above 1 Gy. If the developing time is reduced by 50%, it will be possible to use Foma DF2 films for measuring the doses up to at least 2 Gy. However, the lower limit of the measuring range will also be increased.

Energy dependence of Foma films is shown in fig. 5. As a result of this dependence the speed of DF10 is approximately 17x higher for x-radiation with energy 49 keV (ca 70 kV + 0.5 mm Cu). This fact is apparent from the comparison of fig. 1 and fig. 2 (or fig. 3 and fig. 4). For these reasons, in film dosimetry this energy dependence must be compensated for using some of the published methods. Filtration analysis method yields very good results in the whole energy span 15 keV 6MeV as it is also shown in fig. 5.

Fading, i.e. decrease in optical density with time after exposure to radiation, does not exceed 10% during 3 months in the case of films Foma DF10 provided that the ambient temperature is not higher than 30 °C and relative humidity does not exceed 60%. Fading can be compensated for by an appropriate selection of irradiation time of the calibration film.

All calibration curves and the progress of energy dependence (Fig. 1 to 5) were measured in the Czech National Personal Dosimetry Service (Celostátní služba osobní dozimetrie, CSOD s.r.o., Czech Republic) under the optimum processing conditions.

The stated calibration curves serve for the basic orientation as for the progress of the dependence of optical density on the radiation dose and as for the scope of the practical applicability of the films. As the resulting values may be influenced by the way of processing of the films and the technology of measuring of optical densities, we recommend verifying the calibration under the conditions corresponding to the practical application of the films.

Fig. 1 Dependence of the optical density on gamma radiation dose for the film FOMA DF10

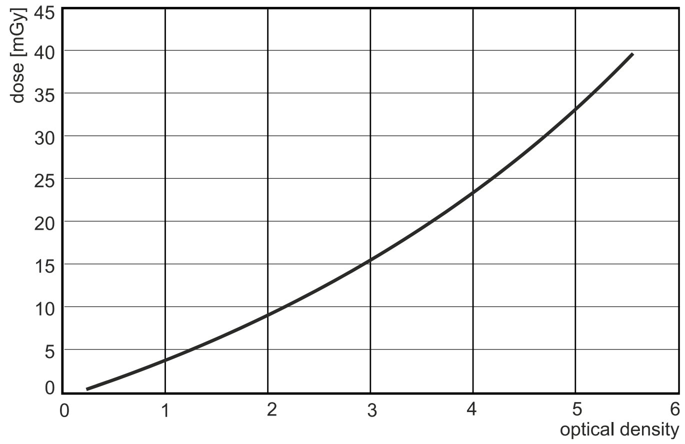


Fig. 2. Dependence of the optical density on x- radiation dose (49 keV) for the film FOMA DF10

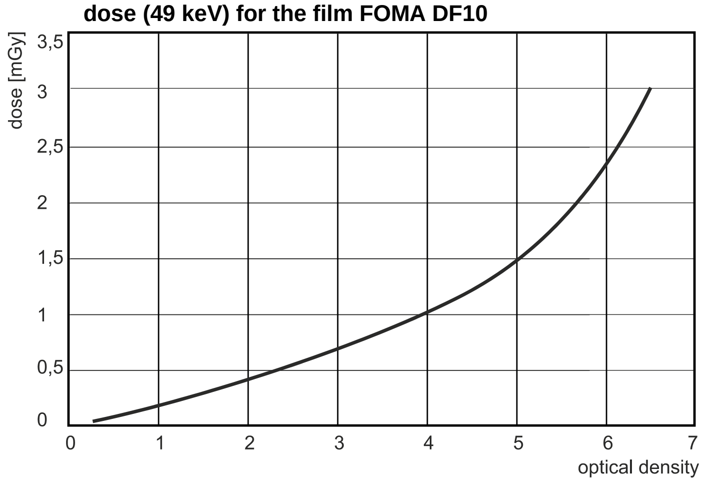


Fig. 3 Dependence of the optical density on gamma radiation dose for the film FOMA DF2

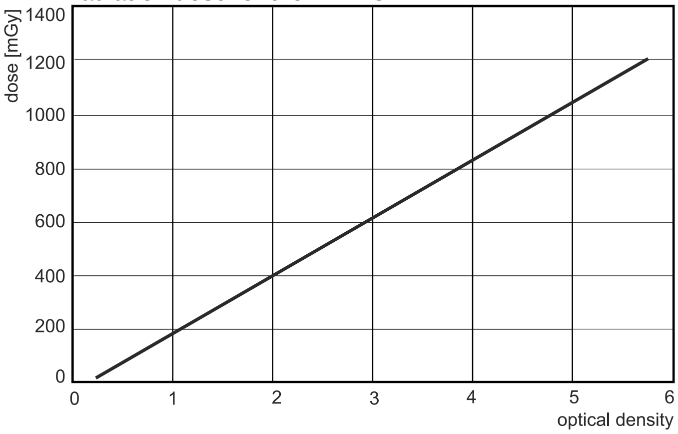


Fig. 4 Dependence of the optical density on x- radiation dose (49 keV) for the film FOMA DF2

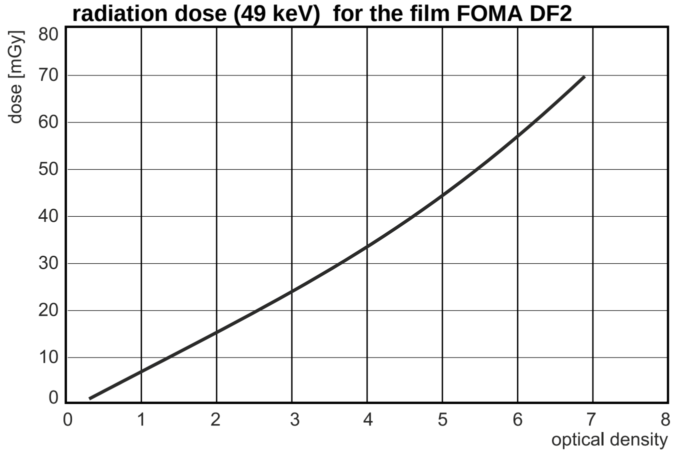
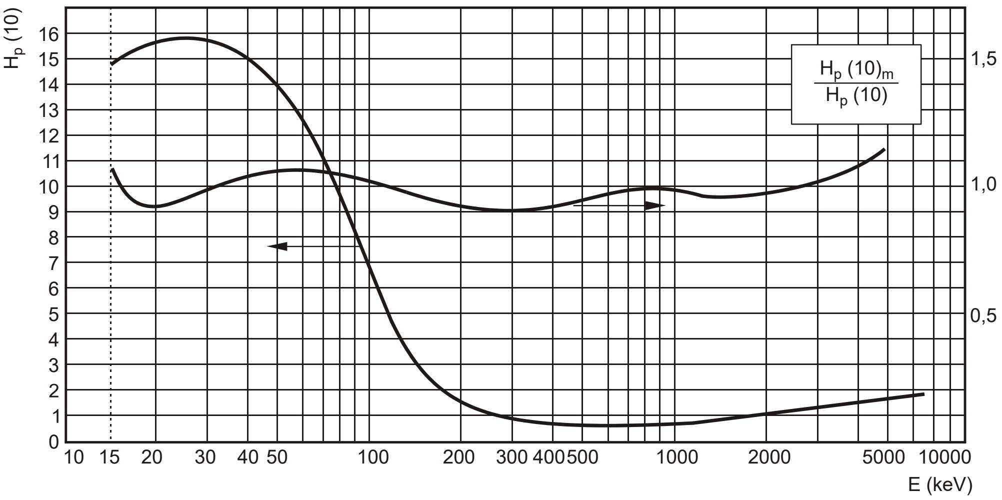


Fig. 5 Energy dependence of the film FOMA DF10 and results of its compensation by the filtration analysis method (measured by National Personal Dosimetry Service).



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