

Radiographic films based upon silver halide emulsions are widely used for relative dosimetry of external radiation treatment beams in the megavoltage energy range. Films are convenient to use and provide a permanent record of the integrated spatial dose distribution over a range of doses from just a few cGy up to several hundred cGy. A modern x-ray film consists of a radiation-sensitive emulsion coated on a transparent polyester base. The emulsion consists of silver halide crystals (typically 95% silver bromide and 5% silver iodide) and gelatin which provides the suspension medium for the silver halide grains. Covering the emulsion is a thin layer of gelatin to protect the emulsion from mechanical damage. When the emulsion is exposed to radiation, some changes occur in the silver halide grains (latent image), which renders only the adequately exposed grains developable. Film development is a chemical process, which amplifies the latent image by a factor of millions. The degree of blackening of a film, optical density, is measured with a densitometer. A plot of density versus log dose, is known as H&D curve.

The use of film dosimetry for determining electron beam dose distribution is well established. The energy independence of film may be explained by the fact that the ratio of collision stopping power in emulsion and in water varies slowly with electron energy. Thus the optical density of the film can be taken as proportional to the dose with essentially no corrections. However film dosimetry for photons is not as straightforward due to preferential sensitivity to the low energy component of the bremsstrahlung spectrum. The silver atoms ($Z=45$) in the emulsion absorbs radiation below 150 KeV preferentially due to the photoelectric process which depends on the cube of atomic number.

However, the measurement of small field dose distributions indicate that the dependencies of emulsion sensitivity on depth and field size which limit film dosimetry for larger field sizes are relatively minor to warrant the use of a single sensitometric curve. Monte Carlo results indicate that even at depth in phantom, the majority of photons in the spectrum have energies above 400 KeV and therefore film does not greatly compromise tissue equivalence in megavoltage beams.

Recently, there has been a resurgence in the use of films for dosimetry for new radiation delivery technologies such as intensity modulated radiation therapy (IMRT), soft wedges (enhanced dynamic wedge, virtual wedge and universal wedge), high dose rate brachytherapy and stereotactic radiosurgery. The characteristic curve of a given type of film may vary from one batch to another, due to the slight variation in the manufacturing process. In addition, the characteristic curve of a film may vary with the energy of the incident radiation, type of the radiation (x rays or electrons), the orientation of the film with respect to the incident radiation and dose rate. However, there are numerous advantages for the film dosimetry that include: excellent spatial resolution limited mainly by the aperture of the light beam in a densitometer, short measurement time, inexpensive, intrinsically two dimensional, flexibility to place in a phantom and is an integrating permanent dosimeter.

Over the past decades there have been a few technical notes and even fewer textbook references describing proper film dosimetry techniques for megavoltage therapy. However, these are scattered throughout the literature and are not easily located and are often contradictory. There is very little guidance for a clinical physicist on the selection and use of silver halide films, film dosimetry phantoms, beam quality issues, optical densitometry equipment, film digitizer artifacts and characteristics, the establishment of calibration methods and film handling protocols, and the errors and uncertainties in the methodologies. A task group of the AAPM, TG #69 has been established to make recommendations on the film dosimetry to the medical physics community. The primary mission of the task group is to develop guidelines for film selection, irradiation, processing, scanning and interpretation to allow optimal external beam dose measurements. Some of these issues will be covered in this presentation.