INTENSIFYING SCREENS, CASSETTES AND SCREEN FILMS

N. Serman & S. Singer

X-rays were discovered by W.C. Roentgen because of their ability to cause fluorescence. X-ray photons cannot be seen. The image produced by X-rays may be captured on a film, may be viewed directly (fluoroscopy) or on a **monitor** with digital radiology.

Roentgen initially used a sheet of platinocyanide to view the fluorescence produced by X-ray photons. It was shortly thereafter that photographic plates were adapted for radiographic purposes.

The combination of screen films, intensifying screens and cassettes are used in making extraoral images. The main function of screens is to reduce radiation to the patient.

Currently, there are two groups of X-ray films for dental purposes:

1. **Non-screen** - Those with emulsions more sensitive to direct exposure of X - rays. These are primarily used as intraoral films and provide excellent image quality.
2. **Screen** - Those with emulsions more sensitive to **blue** [standard] OR **green** [rare earth] light. Emitted when X-rays strike the intensifying screens. The X-ray photons are converted to visible light photons.

Screen film is used for extraoral views, such as panoramic, cephalometric and TMJ imaging. It is manufactured with dyes in the emulsion that absorb specific wavelengths of visible light. Unfortunately, it does not produce the image detail of non-screen films. Screen films are always used IN **COMBINATION** with intensifying screens.

With screen-film, it is mainly the light photons from the intensifying screens that produces the image on the film and not the photons. **Intensifying screens permit a good radiograph to be produced with the patient receiving a much lower dose of radiation.** This film is very sensitive to both X-ray photons and light photons but much more sensitive to light photons.

INTENSIFYING SCREENS.

An intensifying screen is a plastic sheet coated with fluorescent material called **phosphors**. Phosphors are materials which convert photon energy to light.

LUMINESCENCE is the emission of light from a substance bombarded by radiation. There are two types; fluorescence and phosphorescence.

Fluorescence means that luminescence is excited only during the period of irradiation and will terminate at completion of the X-ray exposure. The phosphors in intensifying screens produce fluorescence.

Phosphorescence is afterglow. The irradiated material continues to emit light for a time after cessation of exposure to radiation and will continue to produce an image which you do not want.

The luminescent effect is used radiographically in two ways:

1. To obtain an image on a fluorescent screen as in fluoroscopy, and
2. To increase the photographic response of the silver halide emulsion. In this case the fluorescent material is placed in the emulsion layer on the intensifying screen, in direct contact with the film during exposure. Since X-ray films are coated with emulsion on both sides, intensifying screens are employed in pairs. Each emulsion surface is placed in close contact with the effective surface of one intensifying screen, to avoid loss of image sharpness.

Speeds of Intensifying Screens.

1. Fast screens - thick layer, and relatively large crystals used, maximum speed is attained but with some sacrifice in definition.

2. Slow screens or high definition screens - a thin layer and relatively small crystals are used; detail is the best, but speed is slow necessitating a higher dose of ionizing radiation.
3. Medium screens - medium thick layer of medium sized crystals in order to provide comprise between speed and definition.

There are three types of intensifying screens:

a) Standard - slow screens
b) Rare earth - fast screens
c) Combination

Standard screens use **calcium tungstate** phosphors, while rare earth screens use **gadolinium** or **lanthanum** phosphors. The commercial name for rare earth screens is Lanex.

Rare earth phosphors are more efficient at converting X-rays to visible light thus reducing the radiation further to the patient. The manufacturers name and the type of screen are printed on the one side of the screen and this information appears on the radiograph.

The intensifying screen is placed in a cassette in close contact with a film. The visible light from its fluorescent image will add to the latent image on the film. Its function is to reinforce the action of X-rays by subjecting the emulsion to the effect of light as well as ionizing radiation. The benefit is the reduction in dose of ionizing radiation to the patient.

Characteristics of Intensifying Screens

1) An intensifying screen consists of a base of polyester or cellulose triacetate similar to radiographic film
2) This base must be **radioparent**
3) and **chemically inert**.
4) It must combine characteristics of **toughness** and **flexibility**
5) should neither curl
6) **not discolor** with age.
7) The base is first coated with a **reflective** layer of titanium dioxide to bounce light back onto the film. Divergence of the light rays causes unsharpness of the image.

8) with a uniform homogeneous phosphor layer- standard or rare earth.
9) this is covered with a thin transparent supercoat consisting of gelatin. The purpose of the latter is **protective**, and is very thin and care is always required in handling intensifying screens to avoid any kind of abrasion
10) The **flexibility** of the material is important to allow the screen to bend without cracking - an intensifying screen of this type is used in the panoramic cassette.

Each crystal on the screen emits **bluish** light for **regular** screens (or **green** light for **rare**-earth-screens) Brightness is related directly to the intensity of the X-rays in that minute portion of the image. Thus, over the entire surface of the screen, differences in X-ray intensities are transformed into differences of bluish light (green light) brightness to which the film is highly sensitive. The entire image is thus intensified for recording by the film. The larger the crystals and the thicker the fluorescent layer on the screen, the more light is produced and the greater the intensification. However, the light spreads more widely and the sharpness of detail of the image is decreased accordingly. Manufactures have attempted to improve image quality without sacrifice to film speed by using phosphor crystals of different shapes. An example of this is the T-Mat film that we use for panoramic and extraoral radiographs.

Increasing Film Speed.

1. Thicker phosphor layers.
2. Higher conversion efficiency.
3. Higher absorption phosphor.
4. Decreased resolution of image

The film-screen combination must be matched so that the emission characteristics of the screen match the spectral sensitivity of the film. It is also important to note that when double-loading cassettes, one must use a faster film (e.g.: T-Mat H) or increase the kVp as only one side of each film will be in contact with the intensifying screens.

Regular Inspection

1. Intensifying screens in a flat cassette may come loose and should be re-attached immediately. Loose screens are an invitation to error in the darkroom. It is easy, when loading a cassette, to slip the film on top of both screen if they are unattached.

2. The felt pad or foam rubber in the back of the cassette may have become insecure or worn. This can result in failure of the intensifying screens to maintain uniform contact with the film and this causes a localized area of unsharpness on the radiograph, due to the spread of fluorescent light between the screens and the emulsion. There is nothing that can be done for a cassette which is failing to maintain contact between the intensifying screens.

3. Screens which are old or cracked can be seen to have fairly mottled appearance and this will be reproduced on radiographs. When this is noticed it is time to discard the screens.

As they are sold in pairs, there is little to be done except to replace both screens in the cassette. (Like one glove on its own, it may subsequently never have a match.)

Care of Intensifying Screens

Screens are easily damaged. Their fluorescent emission will be affected if the active surface is soiled even slightly. Screens must thus be kept clean otherwise light photons will be prevented from reaching the screen and creating an image and the screen in that area will appear clear. Dirt will also create "high" spots which will create wear. Screens are best cleaned with antistatic solution. Use a damp cloth and rub gently. Ensure that the screen is dry before closing the cassette otherwise the gelatin on the surface of the screens will stick together. Never leave the cassette open as it will accumulate dirt and dust on the screen.

CASSETTES

Definition: A flat, light-tight container in which x-ray films are placed for exposure to ionizing radiation and usually backed by lead to eliminate the effects of back scatter radiation.

Cassettes are used in association with intensifying screens and screen films. They have related functions:

1. to contain a film
2. to exclude light,
3. to maintain the film in close, uniform contact with both screens during the exposure
4. to protect the intensifying screens from physical damage.

The structure of a standard cassettes suggests a book as it consists of two flat rectangular plates hinged along one edge. The front aspect of the cassette faces the x-ray tube and consists of a sturdy metal frame into which is fixed a sheet of either light metal such as aluminum, or plastic material; the critical point being that it must be transparent to x-rays. The frame constitutes a shallow container into which can be placed thin intensifying screens and a film.

The back of the cassette is constructed from a strong metal. It is customary to spray the internal surface of the back of the cassette with lead paint, the purpose of which is to absorb secondary radiation, preventing it from being scattered back onto the film.

The back of the cassette contains a felt pad. The intensifying screen at the back of the film lies on this felt and is usually glued to it. The function of the felt is to maintain this screen, the film and its fellow screen in uniform, firm contact. The front and back of the cassette are held tightly together, either by spring clips on the edge opposite to the hinge or by means of pivoted resilient metal bars on the back of the cassette. These fit into grooves in the frame.
The cassette utilized with most panoramic radiographs are made from plastic that can bend. However, when they are placed on the drum of the panoramic machine they become rigid, and the functions as stated above apply.

Properties of a cassette:

a) weight - It should be light for easy manipulation
b) robust structure - cassettes in daily use are subject to considerable stress and wear. Screens may fail to maintain contact with the film or leakage of light at the edges can occur. Cassettes deserve and should have stringent care in handling.

c) i. Non flexible - so as not to allow the film to bend.
ii. Flexible cassettes - for panoramic machines.

Flexible cassettes are necessary for the specialized equipment associated with panoramic radiography. They are mounted within a simple envelope of plastic material, folded at one end and fastened with press buttons or velcro of conventional design. The cassette is attached to a drum and is rigid for the duration of the exposure.

d) Size - Slightly larger than the x-ray beam and area to be radiographed.

e) Ease of operation.

Care of cassettes:

Treated with care x-ray cassettes [and intensifying screens] are good for years of hard work. Their general care is aimed at the avoidance of rough handling by all who use them.

It is helpful to mark each cassette, with identifying numerals which are inconspicuous - it makes it easy to eliminate, if radiographic faults are observed, ascribable to damage of some kind. e.g. cracks in the intensifying screens or light leaks. Screens come with a sticker indicating the film speed and this sticker is placed on the outside of the cassette.

Regular Inspection

Cassettes should be inspected at regular intervals to maintain them in serviceable condition. Hinges and clips are subject to stress and their proper functioning should be checked frequently to assure that wear has not occurred. Intensifying screens may come adrift and should be re-fixed immediately. Loose screens are an invitation to error in the darkroom for even with the best of intentions it is easy, when loading a cassette, to slip the film on top of both screens if these are unattached. The felt pad in the back of the cassette may have become insecure or worn. This can result in failure of the intensifying screens to maintain uniform contact with the film and this in turn causes a localized area of unsharpness on the film due to the spread of fluorescent light between the screens and the emulsion.

Flexible cassettes may tear at the edges allowing the entry of light, and this must be regularly checked.

Test for light leaks

Following a number of fogged films, physical inspection of a cassette usually makes evident the admission of extraneous light (black areas) and the points at which it has entered. Broken clips or hinges, buckled corners or loose fronts are the likely causes. Tears often occur at seams and other stress points of flexible cassettes.

Heat diminishes the efficiency of intensifying screens. Cassettes should not be left lying close to radiators or stored near hot pipes. It may be noted that film emulsions gain speed with increased temperatures, but screens lose speed. If the cassette has a plastic front, this may warp and spoil the contact with the front screen, thus reducing the detail of the image.

In the darkroom cassettes should never be stored, opened or reloaded in the vicinity of chemicals. An open cassette lying on the bench almost certainly will be a victim to anything falling onto it (including dust). It is good practice always to leave cassettes closed, and placed on a shelf. Cassettes that are not loaded should not be left locked. Written and posted darkroom instructions should be posted near the darkroom and included in the office manual.

Cassettes need to have the letters R or L (made of lead) placed on the exposure (front) side to indicate the right or left side of the patient. This is for both diagnostic and medico-legal purposes. In the panoramic machines the "L" and "R" are part of the head support of the machine.

A grid is sometimes placed in a cassette to avoid scatter radiation from reaching the film and diminishing the detail of the image.

The screen speed is always recorded on the outside of the cassette to ensure that the film and the screen speed correspond, otherwise the detail and density of the image will be affected.