



XRAY FILMS

*PRESENTED BY:
DEPT OF ORAL MEDICINE & RADIOLOGY*

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INTRODUCTION

A beam of x -ray photons that passes through the dental arches is reduced in intensity by absorption and scattering of photons out of the primary beam.

The pattern of the photons that exits the subject, the remnant beam, conveys information about the structure and composition of the absorber.

For this information to be useful diagnostically, the remnant beam must be recorded on an image receptor.

The image receptor used in dental radiography is x -ray film.

There are two basic types:

1. Direct-action or non-screen film

This type of film is sensitive primarily to X-ray photons.

2. Indirect-action or screen film

It is so-called because it is used in combination with intensifying screens in a cassette.

This type of film is sensitive primarily to light photons, which are emitted by the adjacent intensifying screens.

CLASSIFICATION OF X-RAY FILMS

A. Their use:

a. Intraoral films

i. Periapical films

- No 0 for children
- No 1 for anterior adult projections
- No 2 for standard adult projections

ii. Occlusal films

iii. Bite wing films

b. Extraoral films

Adult PA, BW

#2

Child occlusal

Extra-long BW

#3

Adult ant. PA

#1

Occlusal in adults

Child PA, BW

#0

#4

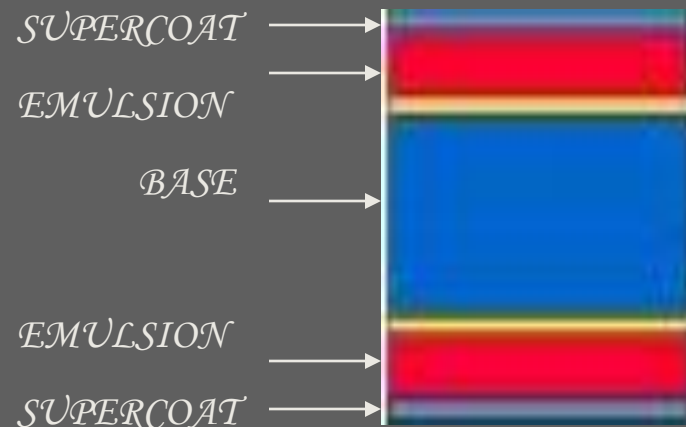
B. Coating of emulsion

a. Single coated:

These produce better and sharper images but the exposure to the patient is more, there fore mostly used in industrial radiography.

b. Double coated:

These films have emulsion on both sides. Most dental films are double coated. These allow for less exposure to the patient.



C. The speed of the films:

a. Slow films:

- *These have small grain of silver bromide and emulsion is on one side only.*
- *Gives better definition*
- *Exposure required is more*
- *Their speeds are denoted by A, B, C*

6. Fast films:

- *Have larger grain size*
- *Emulsion on both the sides*
- *Their speeds are D-ultra speed, E-ekta speed and F-ultra ekta speed.*

c. Hyper speed G:

- *This is a 800-speed film that can halve the patient exposure without blurring image quality.*

D. Packaging

a. Single film packet

b. Double film packet:

➤ *Two films are placed close to each other*

➤ *When they are radiographed the second film serves as a duplicate.*

E. Use, nonuse of screens

a. Screen films

- i. Sensitive to blue light, e.g. calcium tungstate screens*
- ii. Sensitive to green light, e.g. rare earth screens.*

b. Non-screen films

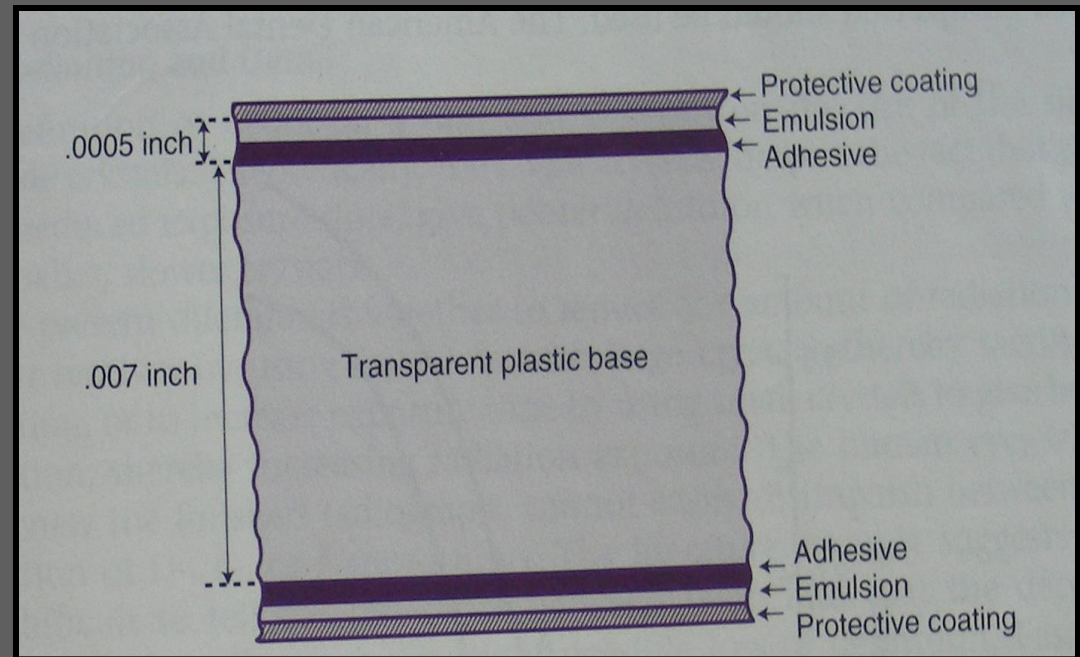
Film Packet

The x-ray film packet is made of plastic or paper, depending on film size. The cover protects the film from light and moisture. The back side identifies the type of film (by color), the number of films in the packet (also by color), and the location of the identifying dot used for film mounting.



COMPOSITION OF X-RAY FILM

1. *Base*
2. *Substratum (sub coating)*
3. *Emulsion*
4. *Super coat*



BASE:

- *It is transparent supporting material upon which emulsion is coated.*
- *Dental film base is composed of polyethylene terephthalate (a polyester) about 0.2 mm thick (0.007 inches).*

The film base should,

- *Have proper amount of flexibility to allow ease of handling*
- *Be translucent, casting no pattern on the resultant radiograph*
- *For optimal viewing of the diagnostic detail the film should have a bluish tint*
- *Be able to withstand exposure to processing solutions without distorting, heat, moisture and chemical exposure.*

The film is known as a “safe film” if the base is made up of acetate polyester, because this is not easily inflammable.

Brief review on evolution of x-ray film base

- ✓ *Original x-ray “plates” consisted of a glass plate with the emulsion coated on one side.*
- ✓ *The onset of World War I cut off the supply of photographic glass from Belgium and created demand for a less fragile x-ray film for use by the Army.*

- ✓ Cellulose nitrate, previously used as a base for photographic film, was adapted for use in x-ray film in 1914.
- ✓ Cellulose nitrate is quite flammable, and several fires were caused by improper handling and storage of the film.
- ✓ In 1924, a “safety” film with a cellulose triacetate base was developed.
- ✓ In 1960 the first medical radiographic film using a polyester base was introduced.

- ✓ *Polyester as a film base offers the advantage of improved dimensional stability, even when stored under conditions of varying humidity and it is much stronger than acetate.*
- ✓ *Triacetate and polyester bases are clear and colorless.*
- ✓ *In 1933 the first commercialized blue tint was added to x-ray film in an effort to produce a film that was 'easier' to look at, causing less eyestrain.*

SUBSTRATUM (sub coating)

It is thin adhesive material on both side of the base

It ensures good adhesion between the sensitive emulsion and the film base.

EMULSION

Two ingredients of emulsion are

✓ *Gelatin*

✓ *Silver halide*

X-ray film has emulsion coated on both sides of the base.

Emulsion thickness varies with film type, but is usually no thicker than 0.0005 inches.

A thicker emulsion would not be useful because of the inability of light to penetrate to the deeper layers.

GELATIN

Gelatin for x-ray film is made from bone, mostly cattle bone.

Gelatin satisfies several exacting requirements better than any other suspension medium.

It keeps the silver halide grains well dispersed and prevents the clumping of grains.

Processing solutions can penetrate gelatin rapidly without destroying its strength or permanence.

SILVER HALIDE

Silver halide is slight sensitive material in the emulsion.

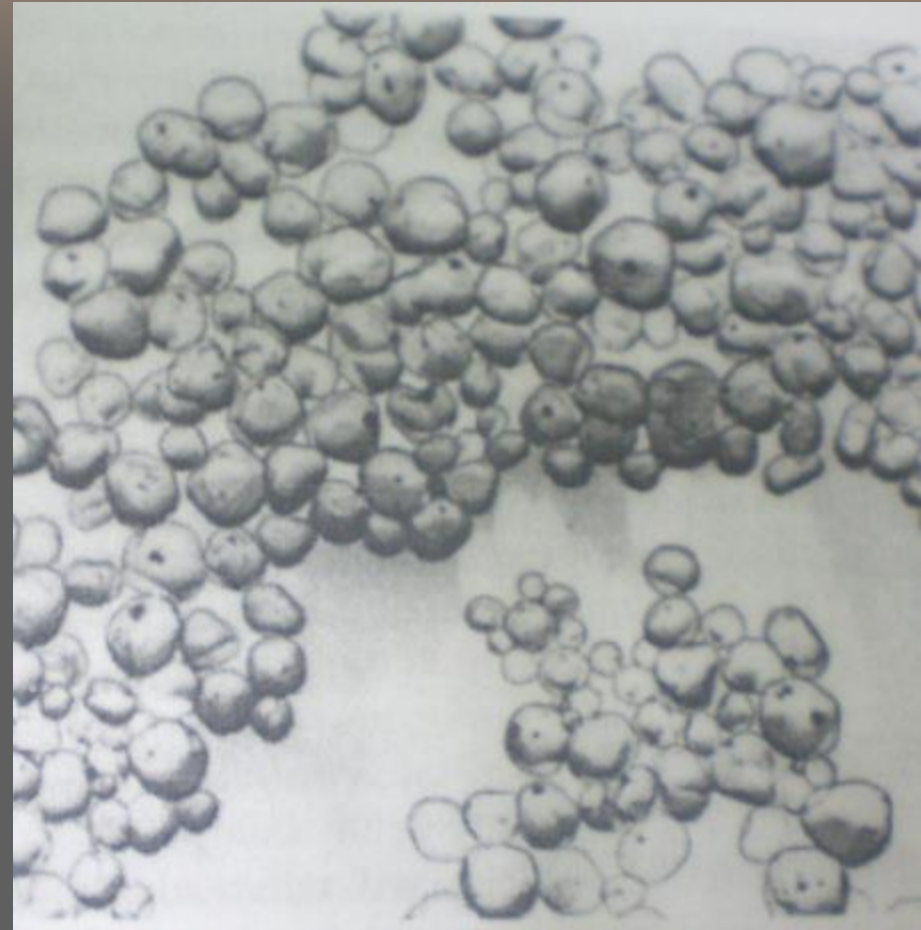
Halide in x-ray film is about 90-99% silver bromide and about 1-10% silver iodide.

The silver iodobromide crystals are precipitated and emulsified in the gelatin under exacting conditions of

- *concentration*
- *temperature*
- *the sequence and*
- *the rate at which these chemicals are added.*

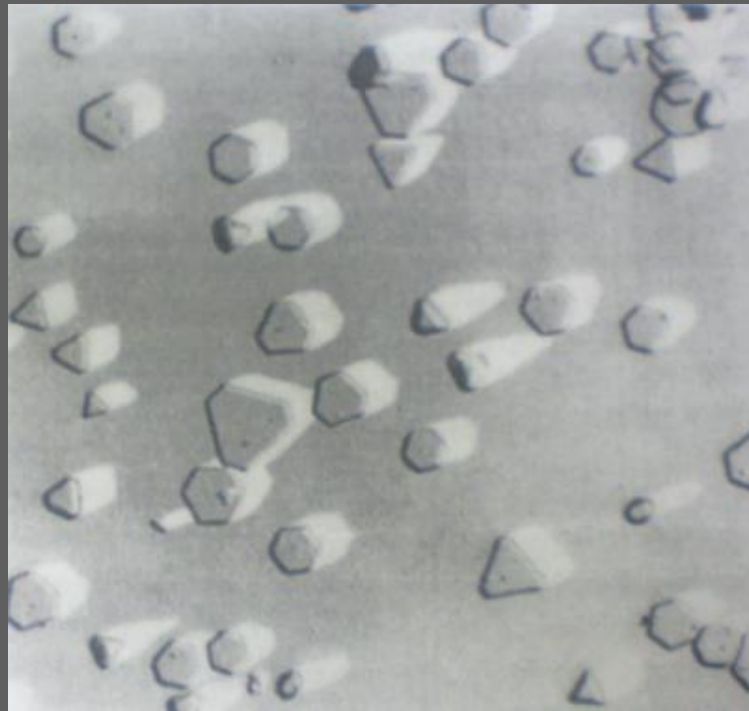
Potato-shaped grains have been used in radiographic films

- These have inherently high sensitizability
- Provide highest photographic speed for a given grain size.



Tubular grains offer several advantages

- They lie flat in the coated emulsion layer
- Provide a larger cross-sectional area per unit grain volume for light capture & larger cross-sectional area of developed metallic silver per unit grain volume for more efficient blackening of the film.



Tubular grains also provide a greater surface area per unit volume so that more spectral sensitizing dye per unit volume can be adsorbed onto the grain surface for efficient spectral sensitization.

Cubic grains provide inherently high film gradient because all the grains tend to demonstrate very similar photosensitivity & acquire developable latent image centers at almost the same exposure.

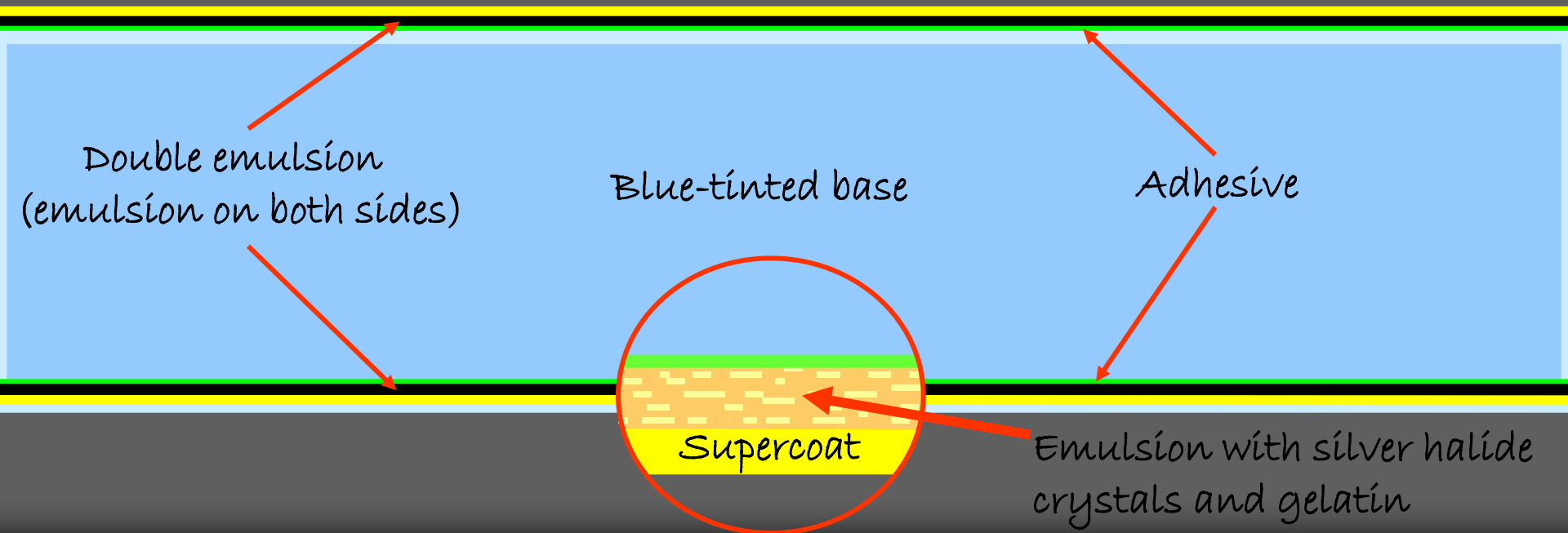
- These have been chosen for some mammography films, for which high contrast is desirable



SUPER COAT

- *It is a protective, transparent, nonabrasive layer over the emulsion.*
- *This is an additional layer of gelatin which is applied to the surface to serve as a protective barrier and protects the film from damage by mechanical handling such as scratching, contamination and pressure from rollers during the automatic processing.*

SUPER COAT



DENTAL INTRAORAL X-RAY FILM

(DIRECT EXPOSURE FILM)

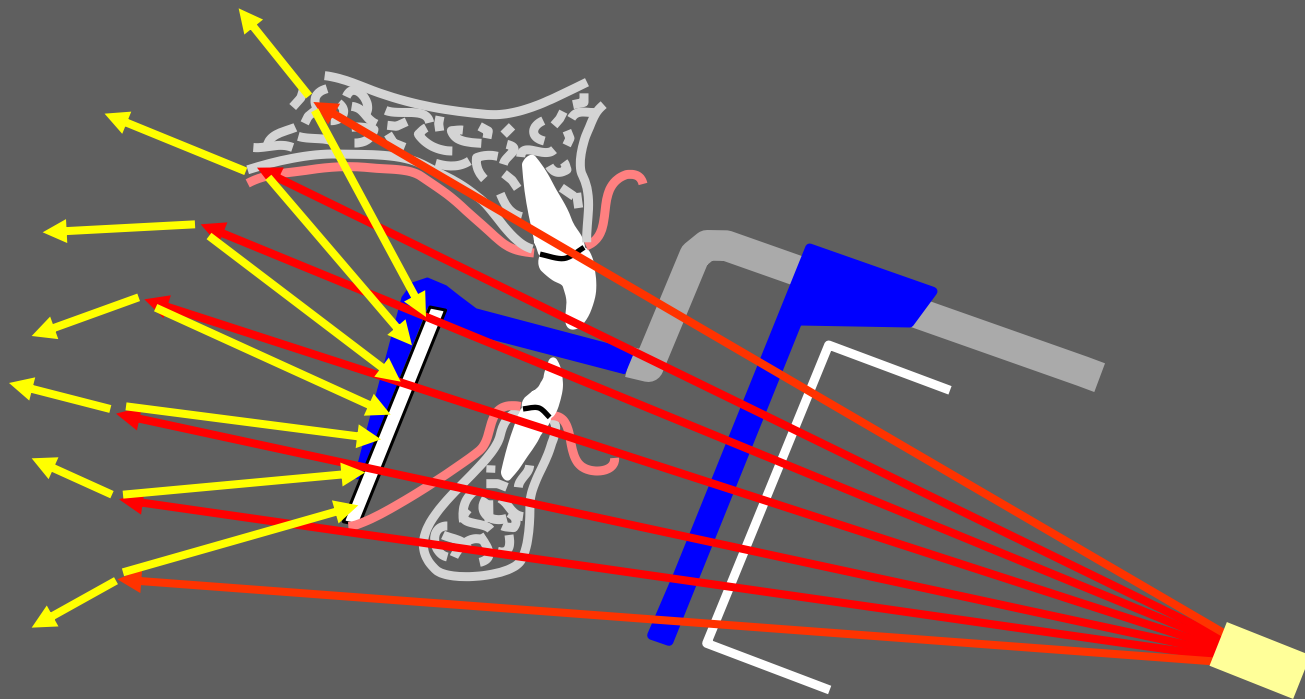
- ✓ Dental x-ray film is individually wrapped in packets of white, pebbled, moisture-resistant paper or polyvinyl wrap.
- ✓ Film is further protected by being wrapped in thin black paper and blacked by a thin sheet of lead foil.





The lead foil placed in back of the film because

- *It protects the film from radiation that may be back-scattered by the tissues of the oral cavity during exposure*
- *It absorbs some of the radiation remaining after the x-ray beam exposes and passes through the film*
- *The lead foil contributes to the rigidity of the packet.*

Scatter (secondary) radiation is produced when the primary χ -rays from the χ -ray tube interact with the patient's hard and soft tissues. Backscatter radiation refers to those scattered χ -rays that go "back" toward the film.



-  *Primary χ -rays*
-  *Scatter (secondary) χ -rays*

All dental films currently manufactured are double-emulsion coated films.

This provides increased speed to the film and requires less radiation to produce an image.

Direct exposure film provides higher resolution images than screen-film combinations.

Some diagnostic tasks, such as detection of incipient caries or early periapical disease, require this higher resolution.

Types of intraoral films

-Periapical film

-Bitewing film

-Occlusal film

Periapical film

Objective of using periapical film is to show the apex of the tooth and surrounding bone and the crown.

There are 3 sizes of periapical film:

The no. 0 – child film (22X35mm)

The no. 1 – (narrow) adult anterior film (24X40mm)

The no. 2 – (standard) adult film for posterior periapicals and bitewings (31X41mm)

Bitewing film

Shows the crowns of teeth of both arches and their interproximal alveolar bone crests on one film.

It has a wing, or tab, attached or placed on the side that on which the patient bites.

Size 2 film is used in adults

Size 1 film is preferred in children.

Occlusal film

It is three times larger than size 2 film (57X76mm)

It is used to show larger areas of maxilla or mandible

The name derives from the fact that the film usually is held in position by having the patient bite lightly on it to support it between the occlusal surfaces of the teeth.

INDIRECT EXPOSURE FILM OR SCREEN FILM

It is designed to be particularly sensitive to visible light rather than to α -radiation

This film is placed between two intensifying screens .

Intensifying screens absorb α -rays and emit visible light, which exposes the screen film

Silver halide crystals are inherently sensitive to ultraviolet and blue light and thus are sensitive to screens that emit UV and blue light.

When film is used with screens that emit green light, the silver halide crystals are coated with sensitizing dyes to increase absorption.

INTENSIFYING SCREENS

Early in history of radiography, scientists discovered that various inorganic salts or phosphors fluoresce (emit visible light) when exposed to an x -ray beam

The intensity of this fluorescence is proportional to the intensity of the x -ray beam.

These phosphors have been incorporated into intensifying screens for use with screen film.

Function

The presence of intensifying screens creates an image receptor system that is 10-60 times more sensitive to x-rays than the film alone.

Intensifying screens are used with all extraoral radiographs.

The resolving power of screens is related to their speed: the slower the speed of the screen, the greater its resolving power.

COMPOSITION

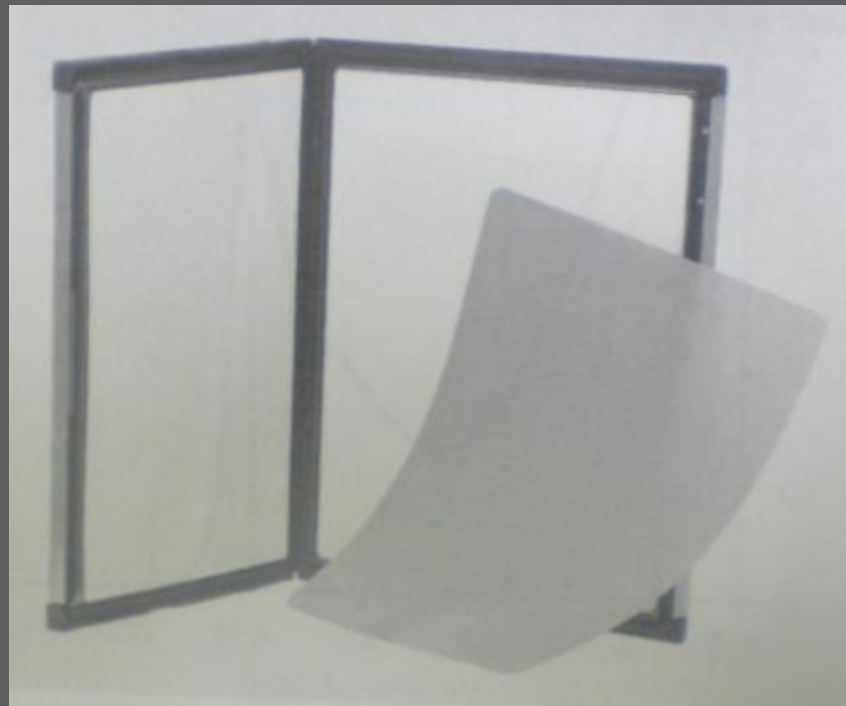
Intensifying screens are made of

- *Base*
- *Phosphor layer*
- *Protective plastic coat*

Intensifying screens are used in pairs, one on each side of the film, and they are positioned inside the cassette.

The purpose of the cassette is to hold each intensifying screen in contact with the x-ray film.

Most cassettes are rigid, but they may be flexible.



BASE

Base material is form of polyester plastic that is about 0.25mm thick.

It provides mechanical support for the other layers

In some intensifying screens the base is reflective which reflects light emitted from the phosphor layer back toward the x-ray film.

*Increases the sensitivity
of the intensifying screen.*

*Results in image unsharpness
because of divergence of light
rays reflected back to film*

Some fine detail intensifying screens omit the reflecting layer to improve image sharpness

In other intensifying screens the base is not reflective, and a separate coating of titanium dioxide is applied to the base material to serve as a reflecting layer

PHOSPHOR LAYER

Phosphor layer is composed of radiation-sensitive phosphorescent crystals suspended in a plastic material.

When the crystals are struck by photons, they fluoresce

*Phosphor crystals are made of rare earth elements, most commonly *lanthanum* and *gadolinium*.*

*The fluorescence can be increased by the addition of small amounts of *thulium*, *niobium*, or *terbium*.*

The first commercial calcium tungstate screens were made in England and Germany in 1896;

They were first made in United States in 1912.

The calcium tungstate crystal used as phosphor must be absolutely free of any contaminant if it is to fluoresce properly.

Rare earth elements are efficient phosphors

A pair of rare earth intensifying screens absorbs about 60% of the photons that reach the cassette after passing through a patient

These phosphors are about 18% efficient in converting this x-ray energy to visible light

Rare earth screens convert each absorbed x-ray photon into about 4000 lower-energy, visible light photons.

Each screen-film combination has its own speed.

TABLE 4-3
Speeds of Various Screen-Film Combinations

MANUFACTURER	SCREEN	FILM	SPEED
Eastman Kodak	Lanex (green)		
	Fine	T-Mat G, T-Mat L	100
	Medium	T-Mat G, T-Mat L	250
	Regular	T-Mat G, T-Mat L	400
	Ektavision	Ektavision	400
Imation	Trimax (green)		
	Fine	XLA+, XDA+	100
	Fast detail	XLA+, XDA+	300
	Medium	XLA+, XDA+	400
	Regular	XLA+, XDA+	600
Sterling	Quanta (blue)		
	Detail	Cronex 10T, 10TL	100
	Fast detail	Cronex 10T, 10TL	200
	Rapid	Cronex 10T, 10TL	400
	Super rapid	Cronex 10T, 10TL	800
	Ultra-Vision (ultraviolet)		
	Detail	Ultra-Vision G, L	100
	Fast detail	Ultra-Vision G, L	200
	Rapid	Ultra-Vision G, L	400
	Super rapid	Ultra-Vision G, L	800

T-Mat G, XDA+, 10T: Medium detail, medium speed, high contrast.

Ektavision, Ultra-Vision: High detail, high speed.

T-Mat L, XLA+, 10TL: Medium detail, medium speed, wide latitude.

Fast screens have large phosphor crystals and efficiently convert x-ray photons to visible light but produce images with low resolution.

As size of crystals or the thickness of the screen decreased,



the speed of the screen declines



sharpness increases.

COAT

A protective coat of plastic (up to 8 μm) is placed over the phosphor layer to protect the phosphor and provide a surface that can be cleaned.

Intensifying action of screens

*The efficiency with which the phosphor converts x -rays to light is termed the **intrinsic conversion efficiency** of the phosphor.*

It is defined as the ratio of the light energy liberated by the crystal to the x -ray energy absorbed.

The intrinsic conversion efficiency of calcium tungstate is about 5%.

One reason new intensifying screen phosphors are faster than calcium tungstate is that the new phosphor has higher conversion efficiency up to 20%

Patient exposure is decreased greatly when intensifying screens are used.

A measure of this decrease in exposure is termed the “intensification factor” of the screen.

The intensification factor of a screen is the ratio of the x-ray exposure needed to produce the same density on a film with and without the screen.

$$\text{Intensification factor} = \frac{\text{exposure required when screens are not used}}{\text{exposure required with screens}}$$

