

# FOMA NDT SYSTEM



# INDUX

## X-RAY FILMS



elongated/worm  
hole porosity



shrinkage  
mark CD4



## FILMS FOR INDUSTRIAL RADIOGRAPHY

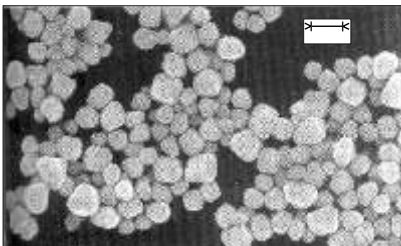
### The tradition and the present

In 1986, FOMA BOHEMIA spol. s r.o. (Ltd.) began the manufacture of new generation of INDUX trade mark films for non-destructive material testing (NDT) of INDUX trade mark. By implementing changes in the production formula of the original NDT film, which had been manufactured since the sixties, the manufacture of film in two speed classes, R4 and R7, began.

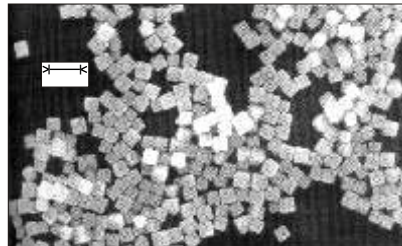
In 1995, a radical modification of the technological process took place. The utilization of controlled precipitation resulted in uniform cubic crystals (grains) of silver halides with a narrow distribution of sizes. The composition of emulsion microcrystals and their narrow size-distribution curve has become prerequisite for high speed and contrast of the film, its high resolving power and low graininess.

Simultaneously the processing in the processing chemicals has been speeded up. The controlled precipitation has become the basic precondition for the stable quality of INDUX line films.

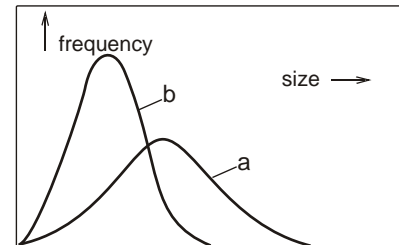
In 1988-1989, the originally manufactured films of R5 and R7 speed class were completed by R4 and R8 speed classes to become an integral line.



a) silver halide microcrystals in the recent-type emulsion



b) silver halide microcrystals in the new-type emulsion



c) comparison of size-distribution of microcrystals frequency

### Programme of industrial radiography (FOMA NDT SYSTEM)

The FOMA NDT SYSTEM includes complete speed series of INDUX line films for industrial radiography, FOMADUX line processing chemicals for manual and automatic processing, automatic processors and additional assortment. The wide range of speeds and quality classes makes it possible for the user to find a film suitable for practically any type of radiographic work, using X-ray appliances and radionuclides.

### Specification and use of INDUX line films

<b>INDUX R4</b>	A very fine-grain, high-contrast, medium-speed film designed for the detection of small critical defects.	Light metal and steel castings, aircraft industry, nuclear energetics.
<b>INDUX R5</b>	A fine-grain, high-contrast, standard-speed film. A standard film for most applications.	Inspection of welds and castings, general engineering, ship building industry.
<b>INDUX R7</b>	A fine-grain, high-contrast, high-speed film for most standard applications.	Inspection of welds and castings, general engineering, building industry.
<b>INDUX R8</b>	A medium-grain, high-contrast, very high-speed film, designed for general use; an additional shortening of exposure times can be reached in combination with fluorometallic screens.	Inspection of thick-walled castings, building industry, inspection of concrete and heavy structures.

### Image quality and classification of film system

NDT films suitable for a specific type of application/work are subdivided by the EN 584-1 Standard according to minimally guaranteed parameters into six groups, denominated C1 to C6. To include a film into a group, four parameters specifying ability of the film to differentiate details in the radiograph are relevant:

- local gradient at optical density  $D_{0.01} \geq 0.01$
- film granularity at optical density  $D_{0.01} \leq 4$
- system parameter T which is defined as the ratio of gradient and granularity at optical density  $D_{0.01} \geq 2$ , and represents the useful-to-disturbing ratio.

### Requirements of the EN 584-1 Standard on a radiographic film system

Group	Local gradient at optical density $D_{0.01}$	Film granularity at optical density $D_{0.01}$	System parameter T
C3	4,1	Q	$\geq 2$
C4	3,8	Q	$\geq 2$
C5	3,5	Q	$\geq 2$
C6	3,5	Q	$\geq 2$

### Guaranteed parameters of INDUX line films according to EN 584-1 and other corresponding Standards

Film type	INDUX R4	INDUX R5	INDUX R7	INDUX R8
EN 584-1 class	C3	C4	C5	C6
ASTM E1815-96 class	I.	I.	II.	III.
Speed 11699-1 (ISO)	T2	T2	T3	T4

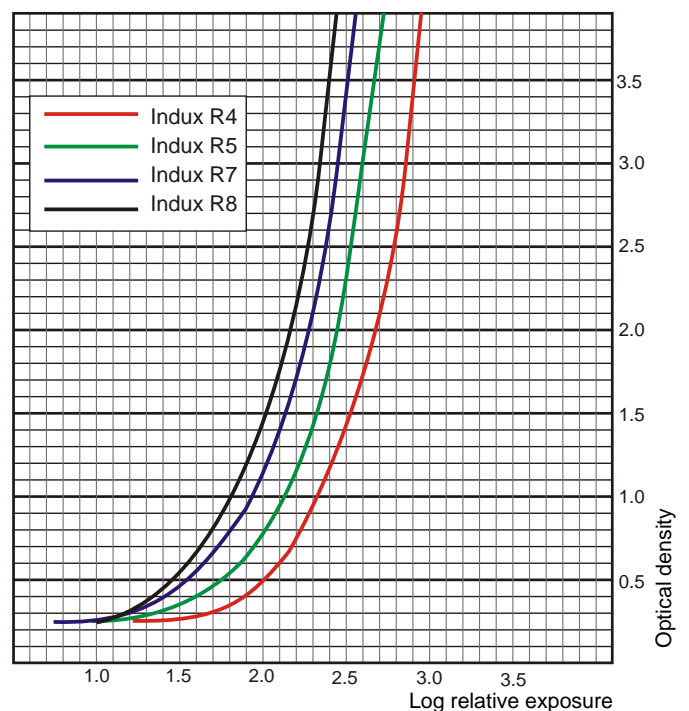
### Characteristics curves of INDUX line films

#### Exposure parameters

X-rays 200 kV  
Cu 8 mm  
Pb screens 0,025 mm

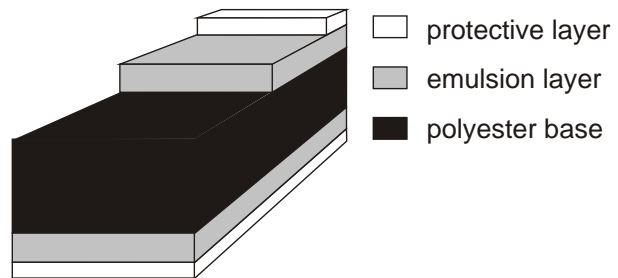
#### Processing parameters

FOMADUX LP-D developer  
developer immersion time 2 minutes at 28°C  
VSF 350 Processors



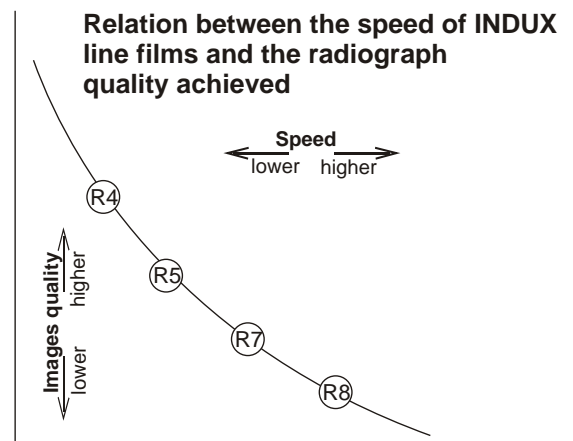
### Film composition

INDUX line films are manufactured by coating of a light-sensitive silver bromo-iodide emulsion on both sides of a bluish polyester base 0,175 mm thick. The emulsion layers are protected against mechanical impacts by effective protective gelatine layers featuring anti-static properties. The sensitivity of film to visible light is reduced by means of a desensitization dye being added to the emulsion layers.



### Optimum image quality

In general, there is applicable to photographic materials that the lower is the film speed, the lower is granularity, and the higher is resolving power. The same applies to films for industrial radiography. Therefore, the correct choice of film is important in view of exposure time, size of the inspected part, and required resolution of defects presented.



### Packaging forms INDUX line films are manufactured in the following packaging forms:

- Daylight packaging (FOMAPAK) – a single-sheet vacuum-sealed packaging with lead screens 0,025 mm thick, sizes: 6x10, 6x12, 6x16, 6x20, 6x24, 6x30, 6x40, 6x 48, 10x10, 10x12, 10x16, 10x20, 10x24, 10x30, 10x40 and 10x48 cm in a box of 50 sheets; format 30x40 cm in boxes of 25 sheets. The FOMAPAK vacuum-sealed packaging ensures optimum contact of film surface with lead screens, simple handling, being light-tight, air-tight and waterproof.
- Darkroom packaging (KB) – sizes: 6x24, 6x40, 6x48, 10x12, 10x24, 10x40, 10x48 and 10x72 cm in a box of 100 sheets; sizes: 10x20, 18 x 24, 24 x 30, 30 x 40 and 35x43 cm interleaved (IF, FW) in a box of 50 sheets. Other sizes are subject to an agreement with the manufacturer.
- FOMADUX ROLLFILM – a daylight roll film packaging sized 70 mm x 90 m or 100 mm x 90 m with lead screens 0,025 mm thick or without lead screens, wound on a paper core and packed in a cardboard dispenser box. A light-tight paper envelope provides protection against external effects (moisture, oils, etc.).
- Packaging forms with lead screens are suitable for use with voltages above 100 kV.

### Sensitivity to safelight illumination

General sensitivity to visible light has been reduced in INDUX line films by adding a filter dye into the emulsion layers. The reduction of sensitivity to visible light does not influence the sensitivity to ionizing radiation. Therefore the INDUX line films may be processed under brighter safelight illumination in darkroom. The danger of unwanted film fog is lower and the operator's fatigue is limited. The INDUX line films can be processed under indirect safelighting with a wavelength higher than 590 nm, as rendered by a dark-red or olive-green safelight filter. A diode illumination with a wavelength over 590 nm is a convenient alternative. It is advisable to test real working conditions in advance.

### Processing chemicals

INDUX line films are designed for both manual and automatic processing using FOMADUX line chemicals supplied as liquid concentrates. For manual processing and automatic processing/replenishment FOMADUX LP-T Developer and FOMADUX LP-D Developer/Replenisher should be used respectively. FOMAFIX is a concentrated rapid fixer to which FOMAFIX H hardener should be added for automatic processing. The processing stability as rendered by EN 584-2 may be checked and documented by means of preexposed FOMATEST SC 981 tests. The tests enable to discover any deviation in processing quality against standard conditions, to decide in time whether chemicals should be changed and improve the economy of film processing procedure.

### Stability of the processed radiographs

The stability of processed radiographs depends on perfect fixing and washing of film. On following prescribed processing conditions, a minimum archiving time of 10 years is guaranteed. To ensure even a longer archiving time, it is recommended to check the processing using the FOMATEST THIO test kit. Correctly processed films have a theoretical life expectancy of up to 500 years.

### Storage

Unexposed INDUX line films should be stored in original intact light-tight packagings, in a dry environment, out of reach of aggressive vapours and gases, at the lowest temperature possible. An ideal storage temperature should be between 5 to 21 °C and relative humidity from 40 to 60%. Long time storage at higher temperatures accelerates unwanted physical and chemical changes in the emulsion layers. Films should be stored out of reach of ionizing radiation with an intensity exceeding 100 nGy per hour.

Films stored in a refrigerator and a freezer should be acclimatized to room temperature for approx. 2 and approx. 6 hours respectively.

Exposed films should be processed as soon as possible.

### Services, consultancy, additional assortment

FOMA BOHEMIA spol. s r.o. (Ltd.) provides for a wide range of technical assistance concerning methods of applying and correctly processing of INDUX line NDT films. The manufacturer also offers additional assortment for the NDT sphere, such as gauges, film viewers, darkroom safelighting, densitometers, and the like.

### Quality assurance programme

The INDUX line films have been subject to continuous improvements. The objective quality checking is guaranteed by an automatic laser checking and grouping inspection equipment. Film speed parameters are tested by a special X-ray equipment and evaluated by an automatic apparatus.

