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Chemistry beyond the ordinary

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Ilford Autoradiography Emulsions

Ilford nuclear research emulsions find wide application in medical and biological research using radioactive tracers, in mineralogical research, in subatomic nuclear physics and in specialized astronomical studies. Ilford nuclear emulsions are used to provide the highest possible resolution of individual β-particle tracks.

Applications

Autoradiography is a major application of Ilford nuclear research emulsions. In its simplest terms, this technique involves introducing a radioactive "label" or tracer substance. Since animals or plants cannot distinguish between labeled and unlabeled compounds in their physiological reactions, the path of labeled materials in living organisms can be traced by introducing a labeled substance into a plant or animal and by putting parts of the subject in contact with a sensitive nuclear emulsion. If a substance has reached a particular point, then the radioactive label will cause exposure of the emulsion in the shape of the source from which the radiation emanates. This technique permits a variety of medical and biological studies.

For tritium studies in which the electrons have very low energy, K.2 may give the best discrimination, while carbon-14 demands the use of K.5. The choice of emulsion depends on the radioactivity being studied and the discrimination required.[1,2]

Availability

The emulsions are supplied in three physical forms – emulsions coated on glass plates, pellicles (i.e., self-supporting emulsion layers;) and as gels (i.e., shreds of emulsions which the user coats onto glass or film base). The pellicles and the emulsions, coated on glass plates, are available on a custom basis.

The emulsions, coated on glass plates, are available in standard emulsion thickness of 10µ, 50µ, 100µ, 200µ, 400µ, 600µ, 1000µ, and 1200µ with a thickness variation up to 10%. The standard thickness of the glass is 1.25 to 1.4 mm. Glasses of different thickness can be made available on a custom basis. The plates are available in dimensions from 1" x 1" to 6" x 12" in whole numbers of inches.

Pellicles are supplied in standard emulsion thicknesses of 100µ, 200µ, 400µ, 600µ, 1000µ, and 1200µ with thickness variations up to 10%. Usually, pellicles are supplied as emulsion sheets interleaved with tissue approximately 25µ thick. By request, sheets of emulsion films are supplied as a "stack", bound between endplates of poly(methyl methacrylate) or glass with adhesive tape. Pellicles are available in dimensions from 1" x 1" to 6" x 12" in whole numbers of inches.

Special glass, treated for emulsion support, is supplied for use with emulsion in gel form as well as for mounting pellicles for processing.

Emulsion Types

The 3 Ilford nuclear research emulsion types consist of silver halide dispersions with distinct average crystal diameters.

Emulsion Type	Avg. Crystal Diameter	General Application
K	0.20µ	Available in a variety of sensitivities. Medium grain size provides good resolution for optical microscopy.
L	0.14µ	Primarily intended for electron microscopic examination of images.

Emulsions of L types are available only in the L.4 form, which are sensitive to all charged particles of any energy, but differ in the grain of the final image.

Type K emulsions are classified as follows

Emulsion	Sensitivity
K.5	Sensitive to all charged particles of any energy.
K.2	For less strongly sensitized recording protons to about 80 MeV ($\beta = 0.4$). Slow electrons produce tracks of a few grains only.
K.1	Records protons to about 7 MeV ($\beta = 0.12$)
K.0	Records protons to 5 MeV ($\beta = 0.1$). Records α-thorium particles as virtually continuous tracks.

Handling

It is frequently advantageous to produce layers of nuclear emulsions as required in the laboratory. Ilford nuclear research emulsion in gel form is ideal for this purpose.

Occasionally, the requirement is for a thick layer produced in situ so as to eliminate the occurrence in the emulsion of tracks produced before receipt of the emulsion. Usually, the need will be for a very thin layer formed on a specimen prepared for autoradiography. The most sensitive emulsions, K.5, and L.4, are appropriate for this application. Shreds of emulsion or gels of the Ilford emulsion types are supplied in light-tight bottles containing 50 cc or 100 cc.

The emulsion should remain in good condition for at least two months and may be usable for a considerably longer period. The shelf-life will depend on the amount of background that can be tolerated in a particular application.

The emulsion must be handled only under safe-lights normally used with blue-sensitive photographic materials such as Ilford "S" Safelight (No. 902) or the Kodak Wratten OC series light filters for general darkroom illumination and Ilford "F" Safelight (No. 904) or Kodak Wratten 2 for direct illumination. Follow general use data, as supplied in emulsion package, or refer to methods for dipping samples in text #2 Rogers, or #3 Williams reference.

Caution: The emulsion bottle must not be removed from its outer wrapper in white light. On receipt it should be stored at a temperature slightly above 0°C.

Storage

Before Exposure - Nuclear research emulsion gels are received frequently by Polysciences, Inc. from England, assuring prompt delivery of fresh materials.

In general, nuclear emulsion materials should be stored in a cool, dry place protected from light and local radioactivity. Ideal storage conditions for plates and pellicles are 10°C with 50% relative humidity. The emulsion shreds or gels deteriorate rapidly above 5°C and should be kept under refrigeration without freezing.

The useful life of the fresh emulsion is determined by the exposure it receives from cosmic radiation and from local radioactive sources. The tolerable level of fogging, caused by these ambient conditions, must be determined by each researcher.

During Exposure - Because "exposures" encountered in autoradiography can range from several days to several weeks, it is essential that the emulsion is kept under much the same conditions as those described above. The latent image loss is accelerated as the humidity increases and, therefore, it is important to avoid high humidities during the exposure period. It is obviously desirable to have sufficient radioactive tracer present in order to ensure that the "exposure" is not offset by latent image losses.

After Exposure - It is extremely important to process the emulsions immediately after the "exposure" time has been completed. The latent image fading is progressively more severe as the crystal size of the silver halide decreases in the order of K.5, and L.4. If there is to be a delay before the emulsion can be processed, then the material should be stored with proper protection from radiation at a temperature between 5-10°C with 50% relative humidity.

Processing Thin Layers (up to 25µ)

The processing of thin layers in autoradiography work can be carried out with any standard high energy developer as Kodak D.19 or Microdol-X developers. Refer to general sheet in emulsion container or references 2, 3, and 4 for details.

Processing Thick Layers (above to 25µ)

As the thickness of the nuclear-emulsion increases, the processing becomes progressively more difficult. Processing procedures for thick layers tend to vary from laboratory to laboratory, since each research group employs techniques best suited to its facilities and experimental aims. Thick layers are used, almost exclusively, in subatomic nuclear physics and users in this specialized field have well established processing techniques.

References

1. Y. Goldschmidt-Clermont, Annual Review of Nuclear Science, **3**, 141 (1953).
   L. Voyvodic, Progress in Cosmic Ray Physics, **2**, 217 (1954).
   C.F. Powell, P.H. Fowler, and D.H. Perkins, The study of Elementary Particles by the Photographic Method, Pergamon Press, 1959.
   Walter H. Barkas, Nuclear Research Emulsions, Academic Press, 1963.
2. A.W. Rogers, Techniques of Autoradiography, Elsevier Publishing Co., 1967.
   C.R. Hopkins and M.G. Farquhar, J. Cell Biol., **59**, 276 (1973).
3. Williams, Autoradiography and Immunochemistry: Practical Methods in EM, Vol. 6, Part 1, 1978.
4. Ilford DATA Booklet, P.S.D.S. #271.

Ordering Information

Since the emulsions are sensitive to all of the factors discussed above, which are beyond our control after they leave our facilities, we cannot be responsible for emulsions which are received over-exposed.

Cat. #	Description	Size
02746	Ilford Nuclear Research Emulsions K.5	50cc
		100cc
02747	Ilford Nuclear Research Emulsions L.4	50cc
		100cc
02757	Ilford Nuclear Research Emulsions K.2	50cc
		100cc
17537	Ilford Nuclear Research Emulsions K.5D	100cc
	(ready to use)	

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