



What goes on in the emulsion that coats film is shown by simple test-tube experiments.

By TRACY DIERS

THE film in your camera is thinly coated with one of the most unstable chemicals known to man. **Silver** bromide is its name, and from the moment of its birth it is kept in a cradle of darkness until in your camera a swift shaft of light seeks it out. The intricate and far-reaching changes brought to **silver** bromide by that flash of light are in part still secrets of nature. Much of what happens in your camera and in the dark-room is known, however, and can be shown at home with a few chemicals in a test tube.

Dissolve a crystal of **silver nitrate** in a test tube half full of water, and dissolve a crystal of potassium bromide in another. If you place both test tubes in direct sunlight, nothing will happen. Mix the two together, and immediately a yellow precipi-

Silver nitrate and potassium bromide are the key chemicals in the emulsion on film and photo-print paper. In crystal form or in separate solutions, they are unaffected by light. At top, purifying **silver nitrate** in a big Eastman evaporating room.

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CREATES A PHOTOGRAPH



Yellow **silver** bromide is formed by mixing solutions of **silver nitrate** and potassium bromide. Light frees bromine gas and leaves dark **silver**.

tate of silver bromide falls to the bottom of the tube. Expose this to strong sunlight or to a photoflood bulb, and it will immediately turn purple. This purplish-colored material is chemically pure silver, freed from the bromine it was formerly attached to. You might say that the reaction was this: Silver bromide plus light equals silver plus bromine. The latter goes off as a gas.

Since it isn't practicable to coat films or paper with a lumpy precipitate, we had to invent some method of spreading the chemical evenly and thinly over the surface we wished to sensitize. The answer was to suspend the silver bromide in an emulsion. Dissolve, with gentle heating, 20 grains of household gelatin in a test tube half full of water. Add a pinch of potassium bromide and then pour in a dilute silver nitrate solution. Silver bromide is again formed, but this time it remains evenly suspended.

In photography the action of the silver bromide is speeded and intensified by the use of a developer. Stock developing solutions consist of a developing agent such as pyro or hydroquinone, an alkali such as so-

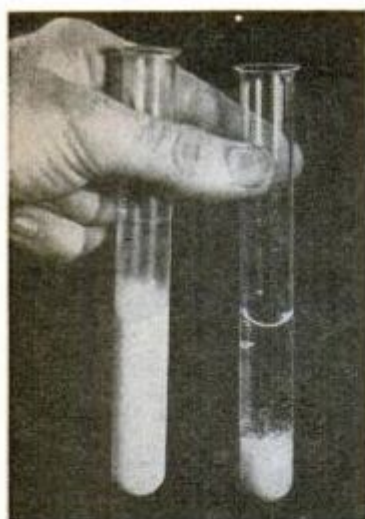
dium carbonate or borax, a little potassium bromide as a restrainer, and some sodium sulphite as a preservative. To show how a developer works, put several drops of any stock developer solution in a flask of silver bromide emulsion that has been exposed only briefly, and not sufficiently to turn dark. The emulsion now turns black in a few seconds—much faster than when light does all the work of separating the silver.

On exposed film, you would now see an image consisting of dark areas of metallic silver and light areas of unexposed silver bromide that the developer has not affected. A fixing bath is next needed to keep these light areas from darkening upon subsequent exposure to light, for if they did the entire negative would turn black and the image would be lost. The fixing bath is sodium thiosulphate, the hypo familiar to every photographer.

You can see how it works by dissolving a few small crystals of sodium thiosulphate in water in a test tube and pouring the solution into half a test tube of unexposed silver bromide emulsion. Immediately the yellow

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← Silver bromide alone would not coat film evenly. An emulsion is made by adding gelatin. In it the particles are suspended as in the tube at the far left.

→ Developing makes more intense the emulsion changes caused by light. A few drops of stock developer in an exposed flask quickly turn the silver black.



suspension disappears, and the tube contains a clear, transparent liquid.

What happens is this. Sodium thiosulphate reacts with silver bromide to form silver thiosulphate, a clear solution; then, if there is plenty of fresh hypo present, the reaction continues, forming complex salts that are dissolved by the remaining hypo.

A simple taste test illustrates the point. Fresh hypo has a salty, bitter taste, and silver sodium thiosulphate is almost as sweet as sugar. Dip a sheet of ordinary writing paper in a solution of 1 oz. of hypo

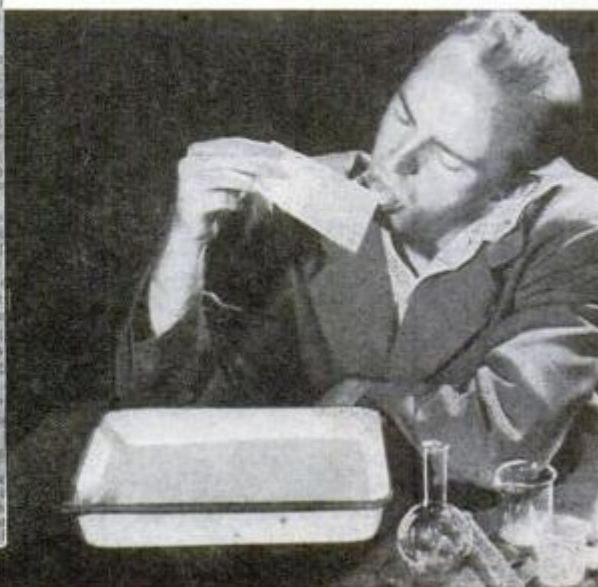
and 4 oz. of water, rinse it in water for a moment, and taste the salty hypo remaining. Then dip a small piece of enlarging paper in the hypo for a few seconds, rinse it quickly, and taste the sweet emulsion side. Return the enlarging paper to the hypo for a few minutes longer, remove and rinse it, and you taste the salty hypo again. Expert photographers avoid stale hypo so that the reaction, or fixing, will be complete and no silver sodium thiosulphate will remain.

Every photographer has taken negatives that were too light or too dense to afford



Fully developed black emulsion in the tube (left) becomes a clear solution when a reducer is added. That's how reducers act on overexposed negatives.

Tasting reveals that too short a bath in hypo, or weak hypo, leaves a sweet salt that in time will stain emulsion. Fresh hypo gets rid of the salt.



good prints. Too light an image may be due to underexposure in the camera, or underdevelopment in the darkroom. A negative of this kind can sometimes be salvaged by **intensification**. Too dark a negative can be improved by **reduction**.

To show the action of a common reducer, first prepare half a test tube of **silver** bromide emulsion, expose it, develop with a few drops of stock developer, and add four or five drops of glacial acetic acid (the photographer's short stop) to halt development. Then add 6 cc. of hypo solution. To the dark emulsion you now have, slowly add a reducing solution consisting of 25 grains of potassium ferricyanide in 1 oz. of water. Watch the dark **silver** particles lighten as they are changed into **silver** ferrocyanide and in that form are dissolved by the hypo. This is the well-known Farmer's reducer.

A common method of intensification is to combine the **silver** deposits of the negative with some denser metal such as chromium or mercury. To show how a typical intensifier works, first make up the usual emulsion, expose, and develop it as before. Add a few drops of glacial acetic acid short stop. Oddly enough, the first step in intensification is bleaching. Add 20 grains of mercuric chloride to 1 oz. of water and pour in enough of this solution to bleach out completely the black metallic **silver**, which in the process is converted into white **silver** chloride.

On a negative, the image seems lost at this step. It is brought back by redevelopment. To your bleached test-tube emulsion, add a little ordinary ammonia water. The emulsion becomes even blacker than it was before; it has been intensified. The new blacker chemical is a very complex salt, **silver** mercury ammonium chloride.

The process of toning photographs, in which the black areas are converted to sepia or some other color, also may involve bleaching and redevelopment. Prepare the usual small quantity of emulsion and develop it after exposure. Add the acetic acid short stop. Then prepare a small flask of bleaching solution consisting of 110 grains of potassium ferricyanide, 110 grains of potassium bromide, and 2 oz. of water. Also dissolve separately in a test tube 50 grains of sodium sulphide in 2 oz. of water. This is the redeveloper.

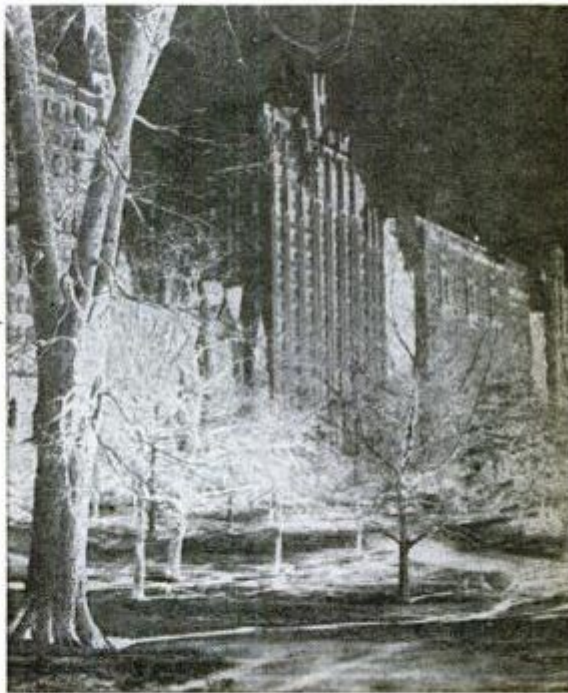
Pour some bleaching solution into the developed emulsion. The black **silver** particles are quickly bleached out into a yellowish substance. The **silver** first becomes **silver** ferrocyanide and then **silver** bromide.

Now pour in some of the redeveloper and at once the emulsion turns brown—in a photo, sepia toning would have resulted. The sodium sulphide in the redeveloper has changed the **silver** bromide to **silver** sulphide, the compound that appears as tarnish on silverware, and this is the sepia tone.

This is the same negative at two stages. Below, it has been underexposed or underdeveloped, and is too thin readily to afford a good, contrasty print.



Here the negative has been put through a process of intensification that makes the image denser by causing the silver deposits to form new compounds.



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