PHYSICS

Instant Color Photography

A new era in color photography is introduced by the color film that replaces the 22 steps in conventional color photography with an instant color process.

By WILLIAM SIEGRIST

➤ FIFTEEN YEARS of intense research by several hundred scientists, engineers and technicians of the Polaroid Corporation have produced its instant color film. They created a new film, Polacolor, that "hands" you a color print about 50 seconds after the photo is taken.

They made this breakthrough 14 years after achieving the process by which the first Polaroid cameras began turning out black-and-white snapshots in a matter of seconds.

Since then the challenge of producing instant color film obsessed Dr. Edwin H. Land, president of Polaroid, and his colleagues. Dr. Howard Rogers, manager of color research, was charged with responsibility for the process research.

Dr. Rogers conceived most of the basic system and the photo mechanisms involved in realizing Polacolor. He is the principal inventor of the key concept of the color-forming mechanism, which is built around a new molecule that links a developer and dye.

Single-Molecule Control

Dr. Rogers' idea was to use a pre-formed dye linked to a developer in a single molecule so the molecule could control its own transfer from the negative to the positive.

In conventional color photography, dyes are not put in the film at time of manufacture but are created after exposure and during processing by the "coupler" method. With a dye linked to a developer in a single molecule, Polaroid is able to put dyes in the film at the time it is manufactured, thus simplifying processing and eliminating most of the variables that might change the character of the dye that reached the final print.

In addition, the developer part of the molecule is used as a mechanism for controlling how much dye stays in the negative and how much reaches the print. This greatly increases the number of dyes that might be considered to meet the requirements for correct color, for stability in the negative and for permanence of the finished print.

An important part of the invention was using a new kind of positive structure that produces an unusually stable and luminous color image on the finished print. The color prints, unlike the Polaroid black-and-white ones, do not require coating or washing.

The challenge was to permit the developer reagent to remain alkaline long enough to develop the negative and form the positive image. Then, in a matter of seconds, it had to change the surface toward a neutral or acid state so oxidation from the air would not muddy the image when the picture was lifted from the camera.

Dr. Rogers and his fellow workers solved the above problem by creating an ionic "hold-and-release" mechanism that holds an acid layer virtually inactive until the negative has been developed and the positive formed.

Near the end of the processing time, the acid layer does its job both by capturing sodium ions (alkali) that migrate to it, and by generating water and circulating it through the image layer to wash out the remaining ions.

Without these ions, the molecules in the image layer around the dyes can get closer together and form a tough bond that embeds the dyes in a clear, brilliant, neutral layer. This gives excellent colors with good stability.

The new color film depends on new chemicals. There are three layers of emulsion containing fine, light-sensitive grains of silver halide. The grains in the top layer are sensitive to blue light; those in the middle are sensitive to green; those in the bottom layer are sensitive to red. When a many-colored picture is focused on the film, the blue, green and red components of the light that has entered the camera form three latent (undeveloped) images on the three layers of silver halide.

Polaroid Corporation

HEADED COLOR RESEARCH—Howard G. Rogers, manager of color research for the Polaroid Corporation, was responsible for the extensive research leading to development of the new, instant color film. He is the inventor of the key concept of the color-forming mechanism, which is built around a new molecule that links a developer and dye.

Conventional color films work in much the same way. Polacolor differs in that just below each layer of its silver halide is a layer containing double molecules synthesized by Polaroid chemists. The molecules are shaped roughly like dumbbells. Each of them has at one end a submolecule of developer. At the other end is a submolecule of brilliantly colored dye, especially matched and composed of the three basic colors. Connecting the dye and developer is a strong chain of carbon atoms.

How Linked Molecules Work

The linked molecules remain quiescent while the film is dry, but after the picture is snapped, a pair of rollers in the camera breaks a pod of thick, alkaline liquid and spreads it evenly over the film. The liquid penetrates quickly through the layers, waking the linked molecules to active chemical life. They start moving, and most of them eventually touch a grain of silver halide in the nearest light-sensitive layer.

If that grain has been exposed to light, it is ready for action. It grabs the developer end of the molecule, holds it tight, and uses it to turn the silver halide into metallic silver. This develops the images in the three light-sensitive layers, and it also immobilizes the linked molecules that have taken part in the developing process.

Only the molecules that have not been captured by exposed grains of silver halide can continue to move through the wet film.

The three superimposed images—blue, green and red—capture developer molecules with dyes of appropriate color attached to them. In spots on the film that have been exposed to blue light the silver halide grains in the top layer capture and hold all the yellow dye, which lies in the layer just below. Since no red or green light has reached this part of the film, the magenta (red-blue) and cyan (blue-green) dyes in the deeper layers are free to move to the surface. Acting together they make a spot of blue.

The same molecular machinery produces the other colors. When green light from foliage forms a latent image on the green-sensitive layer, the magenta dye, which is nearest that layer, is captured. The other dyes, yellow and cyan, are free to go to the surface and become the green leaves in the finished picture. Similarly, yellow and magenta make red. Intermediate colors form at places where the images overlap weakly, allowing fractional amounts of dye to escape.

White light in the picture (such as a

cottony summer cloud) exposes all three layers, capturing all the dyes, leaving no color that will move to the positive. When all three dyes reach the surface, they form spots of black corresponding to parts of the film that have received no light at all.

When the released dyes reach the surface, they hit a sheet of white paper coated with large, stationary molecules of an acid material. The molecules clutch the dyes as they arrive and form them into a tough, many-colored surface that reproduces the colored image focused by the camera's lens. The picture needs no further treatment.

Polacolor represents the logical realization of Polaroid's instant developing method used on its black-and-white film with previous attempts at gaining better color prints.

Kodachrome represented a major improvement in color photography when first introduced in 1935. It had on one film the many layers which do all of the three-color separation work, and made color photography a one-color exposure process.

Kodachrome was a big step ahead from the previous arrangement, the three-color separation process, which called for three separate pictures taken at the same time. The process was clumsy and limited the camera to still subjects or required the use of a special expensive camera that could take all three at once.

Kodachrome was followed by Anscochrome, which allowed the small laboratory to do the color processing.

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GENERAL SCIENCE

News From Science Clubs

➤ COMMUNITY and science fair activities share the spotlight in recent club reports received by Science Clubs of America at 1719 N Street, N.W., Washington 6, D. C.

THE HENRY HUDSON SCIENCE EXPLORERS from Junior High School #125, Bronx, N. Y., are helping their two sponsors make a check list of the fauna and flora of the community and set up a natural wildlife display case.

THE BUSTLING BEAVERS SCIENCE CLUB, Lower Beaver Creek School, Lewiston, Mont., conducted a community cleanup in connection with conservation.

THE BI PHY CHEM CLUB from the South Berwick High School, South Berwick, Maine, has a nature trails project in cooperation with the local state park and THE BIOLOGY CLUB, Liberty Central School, Liberty, N. Y., is organizing one for elementary students.

THE EXPLORERS from Carver Smith High School, Columbia, Tenn., held a Science Symposium for the public. The club presents annual scholarships to outstanding science students in the school.

THE N.S.H.S. SCIENCE CLUB of Naples Senior High School, Naples, Fla., has classified and labeled all the plants on the city's Main Street and received an award from the State Audubon Society.

BIO-SCI members of St. Aloysius High School, Shepherdsville, Ky., completed the Red Cross Home Nursing Course. The club is another that is active in both Science Clubs of America and 4-H Clubs.

Any adult leader may affiliate his or her 4-H Club with Science Clubs of America. This also applies to math, engineering and other groups with science interests.

The ALBERTUS MAGNUS SCIENCE CLUB, St. Mary High School, Paterson, N. J., recently visited the Passaic Valley Water Commission. This trip was to inform students about the problems of water supply and its distribution and to help students appreciate water, a vital natural resource which so many take for granted. More such field trips are planned for the benefit of members.

The members of THE SCIENCE AND ENGINEERING CLUB of Serra High School, McKeesport, Pa., are participating in a school science fair and qualifying exhibits will be entered in the regional fair.

Promotion of a school science fair, camping trip and other field trips are the joint effort of the ASTRONOMY CLUB, CREEPY CREATURES CLUB and CRUCIBLE CLUB of the Lincoln Junior High School, Santa Monica, Calif.

SENIOR SCIENTISTS of the Jackson Junior High School, Jackson, Tenn., help conduct and set up the local science fair and serve as laboratory assistants.

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GEOLOGY

New Moon Map Covers 400,000 Square Miles

➤ A NEW WAY of "seeing" the moon was reported by Robert J. Hackman, of the Department of the Interior's Geological Survey in Washington, D. C.

He reported that the Geological Survey is preparing what is called an "isotonal" (equal-tone) map of approximately 400,000 square miles of the lunar surface. Measuring different tonal values on photographs of the moon, Mr. Hackman explained, would overcome the inability of the human eye to recognize equal tone values in different surroundings. He said that the measured isotonal map could provide valuable clues as to the differences in certain characteristics of the surface of the moon.

Mr. Hackman said that many scientists consider such areas as the lunar maria ("seas") as having uniform characteristics, for the human eye is unable to perceive differences in their reflectivity. Measuring their tones on a lunar photograph, however, clearly demonstrates that the lunar maria are not uniform in reflective characteristics, and thus may vary significantly in chemical or physical form.

He pointed out that the differences in tone values on moon photographs do not all relate to topographic form. This is partly in conflict with the current uniform dust theory.

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