[image removed]

The Composition and Preservation of Instant Films

Annie Wilker
November 24, 2004
The Technology and Structure of Records Materials
School of Information
University of Texas at Austin

In the late 1970s and early 80s Polaroid, the inventor of instant photographic films, offered for sale life-sized replicas of paintings by Raphael taken in Boston's Museum of Fine Arts. Called the Polaroid Museum Replica Collection, the images were made from large-format Polacolor ER film, lacquered, framed, and sold to the public for a less than modest fee. During this period Polaroid also ran many advertisements about the "outstanding" stability of its materials that were said to have "'…remarkable clarity and definition of detail whose color is among the most stable and fade resistant in existence.'" (Wilhelm and Brower 31, 125). Unfortunately, these claims proved to be extremely misleading, since they failed to mention the poor light fading stability of the materials and left customers with badly deteriorating prints (Wilhelm and Brower 31). While instant film had been used to preserve art, not much thought had been given to preserving the film itself. Whether Polaroid had intentionally deceived its customers is unclear, but fortunately today Polaroid and other manufactures of instant materials are more aware of stability issues and preservation problems related to their products. As Leavitt notes, "At first it seemed that the major film manufacturers shied away from this issue, and the matter was raised largely by outside critics, [but in contrast] these firms have now begun to publish some of the most useful information on the subject" ("Two Publications" 36). Even though steps have been made toward a greater understanding of instant materials, many unsolved problems and unanswered questions remain.

The Structure of Instant Materials

Just like the paintings Polaroid set out to reproduce, every instant image is unique. Though the irreplaceable nature of the prints created by this process makes it less than an ideal medium for preservation, it has proved extremely useful in a variety of other purposes. Instant images have been used for family photos, for professional use (by dentists, police, and as test photos for professional photographers) as well as in fine arts. Artists such as Lucas Samaras, Chuck Close and Andy Warhol have taken advantage of the unique qualities of instant images as well as the possibilities these materials present for experimental manipulation of the image (Fitzgerald, "Five Standard").

Not only instant photography's inimitable nature, but also its speed sets it apart from other "conventional" photographic methods such as 35mm negative film. The instant print is generated from an image projected by a camera lens directly onto the final substrate in final size, thus removing the need for an enlargement (Sieber). Additionally the usual considerations of precise timing, temperature control, and a darkroom are no longer needed (Walworth 1003; Keefe and Inch 41). These innovations allow an instant print to be ready for viewing within seconds (Ritzenthaler, Munoff, and Long 46).

Over the years Polaroid has produced more than a hundred different types of instant films in both color and black and white, although many have since been discontinued. A variety of formats as well as chemical compositions are used in these films. Some examples include Land Picture Rollfilm, Land Pack Films, SX-70 Land Films, 600 Land Films, Spectra Films, Instant Slide Films, Pocket Films, 4 x 5 Land Films and 8 x 10 Land Films. Prints, slides, and negatives can all be created from instant materials (Ritzenthaler, Munoff, and Long 46). Though Polaroid has always constituted most of the market, other companies have also produced brands of instant film ("Five Standard"). Kodak, Agfa, the Camera Corporation of America, Fuji as well as a few companies from the former Soviet Union have produced either "Polaroid compatible" films or their own lines of instant materials (Leavitt, "Instant," 136; Kuhn).

In general, the majority of these films have a similar overall structure. Instant film consists of two sheets, one holding an exposed silver halide emulsion and the other an image-receiving layer (Walworth 1003). Each "film assembly" contains all the materials needed to create a finished print or transparency including a negative sheet, positive receiving sheet and developer chemicals. These developer chemicals are sealed in pods that are attached to either the positive or negative sheet (Duffy 7, 11). The film negative itself is made from triacetate or polyester while the type of paper used is resin coated (Ritzenthaler, Munoff, and Long 46; "Five Standard").

The processing involved in creating an instant image varies little from film to film. All of the developing takes place within the film assembly immediately after exposure. The process is outwardly dry and is completed under normal lighting conditions. After exposure, both sheets of the film are drawn through rollers either on the camera or film holder. This mechanical action breaks open the pod of chemicals and releases a viscous developing reagent between the positive and negative sheets of the film. As the film passes through the rollers, this developing reagent is spread evenly between the two sheets and temporarily bonds them together. At this point the action of the reagent produces a negative image in the emulsion layer and a positive image in the image-receiving layer. The development time for instant film is typically 50 to 90 seconds, after which most (but not all) films are then pulled apart to reveal the positive image (Ritzenthaler, Munoff, and Long 46; Walworth 1003, 1004; Duffy 11).

Within a given collection, instant prints should be fairly easy to identity. Most will have a distinct white matte border, while the image itself has a strong gloss. Though many sizes are available, typical prints are either 3 1/4" x 4 1/4" or 4" x 5". Instant prints tend to curl so are often found mounted on self-adhesive boards that were provided with the film. Furthermore, as of 1968 a manufacturing stamp has been present on the back of all Polaroid films identifying the film type and manufacturing date in an alphanumeric code. According to one source, Polaroid has been bought out by Fuji so the images are now called Fuji Polaroids and will have the Fuji stamp on the back (Ritzenthaler, Munoff, and Long 46; Norris 64; "Five Standard").

Black and White Materials

In 1947 Edward H. Land introduced the Polaroid-Land process (Ritzenthaler, Munoff, and Long 46). These first instant images were black and white. Although today there are many types of black and white instant films, the image formation in each is accomplished through a transfer of undeveloped silver halide, unoxidized developer, and unused alkali to the receiving layer. Once in the receiving layer, the chemicals react to create a positive silver image (Walworth 1006, 1007).

Prints that require coating after processing make up one category of instant black and white film. After the film has been exposed and allowed to develop, the image is pulled apart from the chemical layers. Once the chemical layer has been disposed of, the photographer then coats the image with a stabilizer. Until it is coated the print is very susceptible to damage, but afterwards it is extremely stable. Among many others, films of this type include Polaroid's 52, 552, and 612.

Another type of peel-apart instant black and white film does not require a protective coating. Although prints made from this film are easy to use and have an especially good resistance to physical abrasion, they are more susceptible to damage from chemical contaminants than coated black and white prints. Polaroid 87, 611 and 811 are examples of films of this type (Duffy 13, 17).

A third type of instant black and white material produces both a print as well as a negative that can be used to make enlargements. Both the print and negative produced by this film are 3 1/4" x 4 1/4". Like the previous films mentioned, this one also has a peel-apart structure. Polaroid produces 655 P/N and 55 P/N films that are of this type. The processing time is more critical for this film than in other peel-apart films. Either an overly short development time or bright light could cause solarization of the negative while overprocessing could cause developer to stick to the print. The negative produced from this film is thinner than conventional negatives; and so in order to ensure its longevity, it is necessary to clear the negative in sodium sulfite solution to remove any remaining processing gel. Afterwards, it should be washed and dried according to the instructions on the package. The prints from these films should be coated otherwise local fading could result (Ritzenthaler, Munoff, and Long 46; Keefe and Inch 41; Duffy 11, 14, 25).

Instant black and white transparencies designed for projection also exist. Polaroid films used to create lantern slides include Type 46 and Type 146. After processing, these transparencies must be treated with Polaroid's "Dippit" hardening solution to ensure their stability. Polaroid also produces thirty-five millimeter slide films such as Autoprocess 35. These films must be completely dry before being mounted in glass though they may alternatively be placed in plastic mounts for immediate viewing (Duffy 18; Leavitt, "Two Publications," 36).

Color Materials

Color instant prints are produced through a dye diffusion transfer process and include peel-apart, transparency and integral films (Ritzenthaler, Munoff, and Long 54; Walworth 1005; Norris 64). Throughout the years a very large number of variations on these types have been produced, many with their own unique chemistry.

The physical makeup of color instant films contains many more components than found in comparable black and white films. Though there are many distinct types of instant color film, the basic structure consists of a black support material holding separate silver gelatin emulsion layers sensitive to red, blue, and green light. During processing, each of these will form its own separate color record as it releases a complementary subtractive dye (the red-sensitive layer releases cyan dye, the blue-sensitive layer releases yellow dye and the green-sensitive layer releases magenta dye). In between these color layers are spacers that contain alkali-diffusible dye developers (Norris 64; Nishimura). Above these dye and spacer layers sits the image-receiving layer, followed by a timing layer that consists of both a barrier and an acid. Lastly there is an acidic mordant layer that will fix the dyes in place (Norris 64; Harris). The layers are arranged as such to facilitate the chain reaction that takes place during development.

The developer pod in instant color materials contains a strong alkaline reagent in gel, usually made of sodium or potassium hydroxide (Nishimura). The reagent has been made viscous by water-soluble polymeric thickeners and also contains high molecular weight polymers, reducing agents, alkali, as well as components that assist in image formation and stabilization. The pod itself must be inert to strong alkali and able to keep out oxygen and water for long periods of time (Walworth 1004; Harris).

Development technology varies among the types of instant films, but the process used by Polaroid known as alkaline induced dye diffusion transfer is outlined here. After the alkaline developing reagent has been spread over dyes, it forms a uniform layer that serves as a "protective colloid" during processing. (The reagent is spread above the light sensitive layers and below the image layer.) The developing reagent then begins to migrate toward the receiver sheet. While the reagent moves, it changes the exposed particles in each layer into metallic silver. It then dissolves the three developer dyes allowing them to diffuse from their original locations toward the receiver sheet. As the dyes move they are blocked wherever the metallic silver exists. Only dyes from the unexposed areas of the film will reach the receiving layer to produce a positive color image. At the same time the developing reagent is moving down toward the light-sensitive layers, it is also diffusing through the timing layer to eventually come in contact with the layer of acid. Here the acid and alkaline combine to form water and salt. In some types of instant color film the developing chemicals may remain on the surface of print while in other cases they are pulled off and discarded (Walworth 1004; Nishimura; Harris; Norris 64).

There is one type of instant color film that is structurally very similar to peel-apart black and white materials. In color peel-apart film, a final color print is physically separated from its processing chemicals after development. The first instant color film of this type was introduced by Polaroid in 1963 and named Polacolor 1. This product made use of a type of yellow and magenta dyes that turned out to be much less stable than the metallized dyes used in later Polacolor 2 and ER materials. Polacolor film is easily identified by the letter "Z" or "E" at the end of the manufacturing code printed on the back (Walworth 1004; Norris 64, 65).

The second type of instant color film is known as integral. The structure of this type stands out in that the negative, developing chemicals and print paper are sealed in one package that remains intact after processing. All of the chemicals used in development are retained in the film's polyester casing behind the image layer. In most integral color print systems metallized dyes of cyan, magenta and yellow are used and the image itself is formed on a reflective white pigment layer. Above the image layer sits a clear sheet through which the image is viewed. This sheet contains a stable ultraviolet-light absorber that helps maximize the light stability of the print inside. The sheet is colorless and transmits all light above 400nm while very effectively blocking out ultraviolet (Ritzenthaler, Munoff, and Long 46; Norris 65; Walworth 1005; Deane 30).

Standard Polaroid instant integral color prints are 3 1/2" x 4 1/4" overall with image area 3 1/8" x 3 1/8" though sizes up to sizes up to 8" x 10" are also available. These prints can also usually be identified by the date and manufacturing code on the back (Norris 65; Ritzenthaler, Munoff, and Long 46).

Polaroid introduced the first color integral film, Time-Zero SX-70, in 1972. The company discontinued this product in 1976 and then replaced it with similar items such as Time-Zero Type778, Spectra, Spectra HD and 600 High Speed (Pigniolo, Duffy 11). In 1976 Eastman Kodak introduced an integral print film called Instant Print Film PR 10 (Ritzenthaler, Munoff, and Long 46; Leavitt, "Instant," 93). However after losing a 1986 patent infringement lawsuit to Polaroid, Kodak withdrew its instant films and cameras from the market. Tests on Kodak's PR 10 film by Wilhelm and Brower have found its light fading stability to be "far inferior" to Polaroid's integral products and by far the worst color material ever tested (31).

General Considerations in Preserving Instant Materials

The uniqueness of instant images should be a factor in both their appraisal and preservation (Ritzenthaler, Munoff, and Long 46). The irreversibility of damage to these materials is another crucial factor in making decisions about their care. Common types of damage in an aging picture include fading, curling, cracking and discoloration. It is recommended that valuable photos be examined every year or two to catch damage early when it remains possible to slow further deterioration (Duffy 41).

In 1983 Polaroid published a book containing many recommendations on how to successfully preserve their instant imaging materials. Since the company has produced no more recent literature on the subject than this, it must be assumed that the information contained in the 1983 book is still accurate. Whether this is the case or not is debatable. Though quite informative, Storing, Handling and Preserving Polaroid Photographs by Pamela Duffy does seem to be geared more toward the amateur rather than professional conservator. Further doubt has been cast on the methods described here by Doug Nishimura of the Image Permanence Institute. He writes: "I know several of the 'consultants' (from IS&T and ANSI meetings) that Polaroid used from their black-and-white and color research labs. I find it amusing that when I asked *why* they made certain recommendations, that no one seems to remember why (or who made the suggestion)." (Nishimura)

In many cases the book focuses on procedures of the photographer rather than the materials themselves as the cause of deterioration and preservation problems. Though the photographer's technique inarguably plays a role in the stability of the final image, a more thorough exploration of the material and chemical factors involved in image degradation would have been useful. However the lack of concrete conservation research may be a factor here. Since it seems that virtually no sound methods for conserving instant photographic materials exist, nearly all of the preservation options presented are instead preventative measures.

At some points it is difficult to tell the difference between processing problems and problems of deterioration. According to Polaroid, the more closely the photographer follows the instructions provided with the film, the longer lasting the images will be. How the film was handled in storage and processing will affect long-term stability, rather than just impact the immediate results. While creating an instant image, the following procedures may ultimately extend its life: store film in a cool, dry place away from direct sunlight and make sure it is kept on its side rather than on its edge (as this will prevent an uneven distribution of developer chemical inside the pod), use film before the expiration date, do not open film until you are ready to use it, do not put pressure on the developer pod area of the film assembly, do not stack or handle newly processed Polaroid until completely dry, and do not cut or bend photographs (Duffy 11).

As is the case with most photographic materials, instant films and prints should be stored under optimal temperature and humidity conditions in order to ensure their stability over the longest time possible. Since chemical deterioration as well as mold and mildew growth are accelerated in high heat and humidity, it is best to store instant materials at humidity levels of 35% to 40% and at temperatures between 60º – 70ºF (Norris 65, Duffy 23). However, Norris recommends temperatures much lower than this for instant color materials. Regular temperature variations of about 7ºF are also not advisable. While refrigerator storage is preferable for unexposed film, it is not recommended for prints; a professional low-humidity cold storage facility would obviously be preferable. Although high humidity is more damaging than high temperature, extremely low humidity can be harmful as well. Humidity levels less than 30% may cause photographs to become brittle, and more prone to cracking and curling (Duffy 23).

Light is another factor that should be taken into consideration when storing photographic materials. Exposure especially to sunlight and fluorescent light will cause image fading in instant color photographs. If a print must be displayed, it should be kept away from windows, under moderate intensity, low ultraviolet light, for the shortest duration possible. Ideally the light intensity should be no more than 40 foot-candles (Duffy 22).

Incorrect physical handling is another way instant films could become damaged and a few fairly obvious precautions follow. Never use paper clips or staples on instant photographs; aside from scratching or puncturing the film, they also potentially could rust thereby causing additional damage. It is best to handle prints by the edges and to avoid touching the image surface. Abrasion and excessive pressure should also be avoided. Never cut off the white border of either a color or black and white image, as it provides a barrier to atmospheric contamination. Removal of the border also weakens the structural integrity of a photo (Duffy 25, 30).

Outside chemical influences can also have detrimental effects on instant photographs. Prints should be stored in containers having a pH between 7.0 to 8.5 and far from acidic or extremely alkaline substances. If possible, instant prints should be kept away from air pollution and should be removed from spaces that are going to be painted or varnished and not put back for at least a month in order to avoid contact with harmful fumes (Duffy 22, 28).

Polaroid provides a long list of materials that could cause damage to instant photographs: sulfur and nitrogen, chlorine, peroxide, hydrogen sulfide, ozone, ammonia vapors, auto exhaust fumes, fumes from paint, varnish, solvents, bleach and cleaning agents, wheat or starch pastes, rubber cement, white glue, synthetic glues, vegetable and organic glues, certain types of heat sealing mounting tissues, “magnetic” photo albums, Polystyrene (Styrofoam), paper with a high content of sulfur compounds (such as certain black papers), brown kraft paper (contains lignin and metallic sulfates), unstable plastics (such as polyvinyl chloride and polystyrene), ordinary cardboard, wood containing glue such as pressboard or plywood, recently varnished or painted surfaces, glassine envelopes, inks from pens or rubber stamps, rubber bands (may contain sulfur), insecticides, fungicides and tap water. Additionally, instant materials should never be stored in contact with conventionally processed photographic materials. This situation could be particularly problematic if the other photograph has not been fixed or washed properly (Duffy 23, 28, 29, 33).

Materials that *are* considered acceptable for storage include boxes made of acid-free paper or card, cellulose acetate, polyethylene, polyester sheeting and sleeves, aluminum, stainless steel, materials coated with baked enamel, glass, porcelain and acrylic plastics. Prints and negatives should be stored individually in either polypropylene sleeves or in envelopes made of acid-free paper with high alpha-cellulose content; Polaroid especially recommends PermaLife paper. Never store prints unless they are completely dry. If stacking images, place a piece of acid free tissue paper as a protective separating sheet between all pictures ("Procedures"; Duffy 11, 25, 28).

Aside from storage between sheets of acid free paper, Polaroid offers a few other options that may or may not be sound conservation techniques. The first is to mount the image between pieces of museum board using linen tape. The goal here is to protect from mishandling and damage and to keep print contamination to a minimum. Another possibility is to store instant materials in chemically stable albums. Though this method may protect images from light, facing photographs potentially could abrade one another. Chemical interactions between prints could also cause problems. A final, possibly problematic option would be to apply a layer of lacquer to instant prints. Polaroid recommends the brand Pro-Tecta-Cote and maintains that a layer of lamination will protect images from fingerprints, abrasion and liquid spills. It purportedly deters oxygen and moisture and slows the fading of images exposed to bright light for extended periods (Duffy 28, 29, 36). Until tests have been done to examine the chemical interactions of this lacquer and the prints, and how the print will act without exposure to air, it remains unclear whether this is a viable option.

Preserving Black and White

The major problems associated with aging black and white instant prints include fading and discoloration. Fading is most common around the edges of the photograph while discoloration occurs in patches. Both of these problems are generally caused by outside chemical influences. Another problem often encountered with black and white instant prints is curling. Prints are especially likely to curl if they are stored in very low relative humidity or if they were over processed. According to Polaroid, many of the problems in preservation of its black and white films can be averted by carefully following each film’s directions: where appropriate, proper washing and clearing are essential in addition to proper coating. Cases in which these procedures were not followed by the photographer caused the resulting images to be much more susceptible to chemical damage from outside sources (Duffy 23, 25).

Polaroid places a lot of emphasis on the proper coating of its black and white prints in order to ensure their longevity. Coated prints may also be recoated to eliminate damage from fingerprints, scratches or water stains. Although it is far from being a sound conservation practice, Polaroid recommends first removing the original print coating by washing it in 6% acetic acid or white vinegar, then rinsing in cold water. It is best to allow the print to air dry since forcing the print to dry will cause it to curl. During this time the print is extremely vulnerable to damage and should be handled with care.

Once the print is dry it may be recoated. Coated prints that have inadvertently become adhered to one another may be unstuck by a similar process. Dampening with 6% acetic acid or white vinegar should unstick the prints. Once apart, rinse, dry and recoat. A coated black and white print with water damage can also be repaired by removing the coating as above. After the coating has been removed, soak the print for a few minutes in a wetting agent such as Photo-Flo, allow to dry and then recoat (Duffy 13, 41).

Aside from recoating, one of Polaroid's primary recommendations for increasing the longevity of its black and white materials is selenium toning. Duffy provides detailed instructions on how to selenium tone black and white Polaroid prints and negatives. This process increases the stability of the image but alters the tone of the original. It is also irreversible so most likely would not constitute a conservation treatment. However, the Polaroid Land films most suitable for toning include Types 552 and 52 4x5 film. Though it is not recommended that coated prints be toned, the coating may first be removed and then reapplied after toning. Another possibility is to make a copy onto Type 52 film first and then tone that. Polaroid especially recommends the use of Kodak Rapid Selenium Toner (Duffy 36, 37).

In order to deal with discoloration in its black and white prints, Polaroid recommends copying the image onto panchromatic film using a filter that matches the color of the stain as closely as possible (Duffy 42). The stain should then be nearly invisible in the new image.

Black and white prints that require coating after processing, assuming the coating has been applied properly, should be very stable (Duffy 13). If prints such as these have become stuck together or damaged with fingerprints, they can be recoated by following the instructions given above.

Dirty, coaterless black and white prints however should be washed in cold running water for about 30 seconds and then allowed to air dry. While the prints are drying, it is important not to touch the image area since the surface is extremely fragile when wet. Once the print is completely dry, a layer of print coater can be applied. This may improve appearance but will not greatly increase the image's stability. Coaterless prints also have a tendency to curl, especially if they have been over processed. It is best to flatten these prints by first placing them in moderate relative humidity and then under a weight for a few days rather than bending against the direction of the curl (Duffy 17, 25, 41).

According to Keefe and Inch, Polaroid's Type 665 Positive/Negative Film can be considered of "archival quality" (41). However there are a few preservation recommendations specifically for these films that do exist and could be followed. Although most of these procedures are intended to be carried out during the production of the photograph, they can also be done at a later date. Since the negatives produced by these films are easily damaged, extra strength can be gained by the use of an acid hardener. Place the negative in the hardener for about 2 minutes, then rinse in water for about five minutes. It is important not to overwash or use water that is too warm (it should be no higher than 75ºF) since this could cause the film emulsion to soften and become more susceptible to scratches. The prints from this type of film are coated and if necessary may be recoated (Keefe and Inch 41; Duffy 14, 25, 36).

When instant slide films such as Polaroid's Autoprocess 35 Transparency film are stored in areas where conditions of high humidity or excessive pollution exist, gold toning is recommended. Since the silver image layer in this type of film lies on top of the film base rather than underneath a layer of gelatin, it is very susceptible to atmospheric influences. Gold treatment provides a noncorrosive, supposedly permanent protective coating over the silver image particles. A benefit of this process is that it will not affect image color as with selenium toner. However, unless Autoprocess 35 Transparency film is stored under extreme conditions, gold toning should not be necessary because of the sophisticated image stabilizing chemicals in these films (Leavitt, "Two Publications," 36, 112).

Preserving Color

Like all color materials, instant color images are much less stable than black and white products. But even the longest lasting Polaroid instant color prints are not as stable as images made on chromogenic color paper. In lit conditions the dyes in instant images tend to fade while in dark storage an overall yellowing is common. Different types of instant color materials deteriorate in different ways dependent on structural configuration, type of image dyes used, storage environment and how the film was originally processed (Norris 64, 66). The unique nature of instant prints poses an additional problem to their preservation. It is inadvisable to use instant color materials for anything other than short-term applications (Pigniolo).

Debbie Hess Norris has worked to preserve a collection of the deteriorating instant color photographs taken by Andy Warhol throughout the 1960s, 70s and 80s. In her preservation plan she recommended prohibiting the exhibition of original Polacolor and SX-70 materials. Instead of showing the originals she advised that all images requested for loan be duplicated (66). Making copies of irreplaceable color photographic images is also suggested as a general practice by Wilhelm ("Color," 107). He suggests making duplicates from internegatives using Fujicolor Super FA Paper; Polaroid itself offers to make Fugicolor copies (Norris 66; Wilhelm and Brower 124). An alternative method to duplicating a color photograph involves taking separation negatives on black and white film. This could be beneficial because black and white materials will deteriorate at a much slower rate. However this process can be very costly. If the content rather than the color is of primary importance in the image, a black and white duplicate is a simple and inexpensive option (Duffy 36). Barbara Brown at the Harry Ransom Humanities Research Center suggested digitizing deteriorating materials. This method could be carried out faster and with fewer chemicals than other options, making it a reasonable choice especially if dealing with a large collection of images rather than a single piece. Additionally, color corrections to account for fading could be made digitally on a copy with no potential for damaging the original.

While the copy can be displayed, the original should be kept in dark humidity-controlled cold storage (Norris 66; Wilhelm and Brower 124). A temperature of 0ºF and relative humidity of 30 percent is recommended specifically for color materials (Wilhelm, "Color," 107). Cold storage will increase the life of color materials by preserving both the gelatin emulsion and base material. It turns out that it is more cost effective to control the relative humidity of a vault than to keep images in non-humidity-controlled storage inside vapor-proof containers. Furthermore, if the prints are relatively new it is best to store them at moderate temperatures with good air circulation for a few weeks before enclosing them in storage containers or frames. This will allow the excess moisture contained in the print to completely evaporate. The more thoroughly prints are allowed to dry at this stage, the less likely they will be to develop a yellow stain in dark storage (Duffy 11).

Of the instant color materials available, the peel-apart variety seems to be the most stable. Because all prints of this type are completely free of chemical processing reagent, they are exceptionally stable in dark storage (Wilhelm and Brower 124). However they do tend to fair worse in lit conditions. Of all instant materials, Wilhelm and Brower recommend Polaroid Polacolor ER, 64T, 100, and Pro 100 Prints, all of which are peel-apart in format (6). Of these, Polacolor materials seem to be most widely studied.

Overall, the dark storage stability of Polacolor peel-apart films is satisfactory though issues of fading can be problematic. Norris has found that Polacolor 1 has excellent dark storage stability. However, subsequent products such as Polacolor 2 and ER, while having improved color saturation, also exhibit poorer dark stability. Upon aging in dark storage, yellowing in these products will not be limited to the minimum density areas but will occur throughout the entire image (65).

With each successive peel-apart product Polaroid produced, an attempt was made to improve the poor light stability of these materials. The original Polacolor 1 film faded quite a bit when exposed to bright light even for a moderate period of time. Because of a switch to the more stable, metalized dyes used today, Polacolor 2 films are more resistant to fading than their predecessors. Though Polacolor 2 is somewhat more resistant to fading in bright conditions, when it does fade there is also usually a shift in color balance. This shift results from the different rates at which each of the three dyes fades. More recently Polaroid has made further improvements to its Polacolor ER film dyes. In addition to enhanced stability in bright light, the dyes in this film all fade at nearly the same rate, thereby reducing any shift in color balance. According to Polaroid this makes the fading that does occur seem “less objectionable.” Even with these improvements, all Polacolor materials will still show signs of fading. A test exposing Polacolor prints to 300 lux tungsten light for 12 hours a day shows that a loss of dye density and color shift will occur after only two to three years (Norris 65; Duffy 22).

If peel-apart materials must be displayed, there are several methods recommended by Polaroid to deter fading, some more practical than others. One option is to coat the prints using a protective spray developed by the Polaroid Research Laboratories. This layer has "proven very effective" at shielding images from UV radiation, thereby keeping dyes brighter and white areas whiter. Another, more reversible option, would be to mount the photo behind a protective transparent cover. Finally, if a particular room is used to display these images regularly, it is best to install special windows to filter out the UV radiation in daylight (Duffy 22).

Aside from fading, Norris has also noted a few problems caused during the processing of Polacolor prints. She found that many of the Polacolor prints in the Warhol collection had a purplish-red discoloration around the border. This so-called "red frame" effect is not related to image instability but instead to the angle and pressure at which the film was pulled through the rollers. If the print had been pulled through at an odd angle, the developer would not be distributed evenly across the print and a reddish border would result. This problem seems to mainly exist in earlier Polacolor materials (65).

White specks or non-image areas also appear in some early Polacolor materials. These too are caused by the action of the film moving through the roller. If the film is pulled too quickly, air will mix with the developer thus causing bubbles to form. The bubbles will then block the developer and prevent any image from forming in those areas. If the print had been pulled in too slow of a motion, the losses tend to have an elongated shape. Poorly oriented camera rollers are usually the cause of these problems (Norris 65, 66).

Although the fading and staining of peel-apart materials is irreversible, solutions do exist for a few minor problems associated with these prints. "Superficially soiled" Polacolor images can be cleaned by lightly rubbing the entire surface of the print with a cloth or cotton ball dampened in mineral oil. The print is then cleaned again, this time with turpentine, in order to remove the oil (Duffy 41). Curling Polacolor prints are common, especially under conditions of low relative humidity. These prints should be physically restrained in storage to help prevent further planar distortion (Norris 65).

In terms of fading and dark storage stability, instant integral color prints have an opposite set of problems than images made from peel-apart films. While both types have poor image stability in general, the dark storage stability of integral images is particularly problematic. In some cases the protective cover of integral films may hinder damage, while in other cases cause it. Polaroid's SX-70 color prints were "quite a sensation" when introduced in 1970 (Wilhelm and Brower 31) and still seem to be the most studied of all the varieties of instant film.

Duffy believes that the instant photos from integral films are the least likely to deteriorate by chemical action. This assumption is based on the fact that both the front and back of the image are protected by "chemically resistant" polyester sheets (23). However, according to Dean, no research has been carried out on the ability of the polyester coating to preserve the image. In his opinion, the cover sheets end up preventing the oxidation of chemical residues left over from processing, thereby contributing to deterioration (30). Though the two polyester sheets of integral film are sealed, this seal apparently is not very strong. Since it is known that these photographs lose water for a couple of weeks after development, it is clear that moisture is capable of moving either through the polyester or out around the edges of the border (Nishimura).

While the polyester coating may exacerbate chemical problems, it does effectively serve as a physical protection for the image. The UV filtering material in the transparent cover blocks much of the harmful light that could damage the print. Removing the polyester sheets will increase the probability of image degradation and color fading. For this reason it is best not to cut integral films. Cutting or bending these prints could also cause the image layer to separate from its base, ultimately leading to the destruction of the picture. Bending or any pressure on the image area, especially soon after processing, will leave permanent marks on the image. Unusual physical considerations such as these are relevant when working with artists' prints that have been manipulated in the development phase or transferred to other supports (Deane 30; Duffy 11, 25).

When displayed, Polaroid Spectra, 600 Plus, SX-70 prints fade much faster than typical chromogenic photographs (Wilhelm and Brower 124; Norris 65) though somewhat less dramatically than color peel-apart prints (Pigniolo). Fading occurs to a much greater degree in integral prints when they are kept in dark storage. Although Polaroid claims that these images have very good dark storage stability (Duffy 22) and show no dye loss, all other sources seem to disagree. According to Wilhelm and Brower these prints will develop an excessive yellowish stain that could appear within a few months of dark storage in normal room temperature (Wilhelm and Brower 6, 31). The stain results from non-image dyes or other chemical substances in the lower layers of the print package migrating to the image receiving layer (Norris 65; Wilhelm and Brower 124). Areas of minimum print density are particularly prone to staining (Deane 30).

Though Polaroid does not directly admit that its integral prints are susceptible to yellow staining in dark storage, they do recommend a method of removing this stain. Duffy believes that by exposing a yellowed integral print to bright xenon arc, daylight or fluorescent light for a few days the stain will effectively be bleached out. However, care must be taken not to use excessive amounts of light because this could then cause fading. The possibility of yellow staining can be decreased by ensuring that prints are completely dry before placing them into dark storage (Duffy 11, 42).

Another problem common to instant integral prints is “catastrophic cracking” in the image receiving layer. These cracks occur beneath the transparent cover while the backing sheets and cover itself remain intact. Especially low or fluctuating relative humidity is most likely the source of this problem. Cracks are not caused by light unless accompanied by a large amount of heat. Unfortunately as of yet there is no accepted accelerated test for cracking. Although image layer cracks are common in older Polaroid integral color prints, it has not yet been seen in Kodak or Fuji instant materials (Pigniolo; Wilhelm and Brower 25, 31, 125).

Since the vast majority of the deterioration in instant integral images is irreversible, Polaroid has little advice to offer on improving the condition of these prints. It seems the only option is to clean the surface with a cloth dampened with water (Duffy 41). Anything other than pure water is inadvisable since it will likely seep through the print’s plastic cover or under the border and eventually reach the image layer. Though practiced in the past, it is not prudent to clean an integral print with glass cleaner since it is an alkaline solution. After entering into the film assembly it will cause image dyes to migrate thereby destroying the picture (Nishimura).

In recent years more consideration has been given to the longevity of instant materials. Unlike Polaroid’s failed attempt at art preservation with its Museum Replica Collection, many images at the Royal Photographic Society in England were successfully copied and saved with Polaroid 665 Positive/Negative Film in 1987 (Lester 826). Polaroid has also begun to manufacture what are, according to Wilhelm, the first “truly permanent” color prints aptly named Permanent-Color ("Color," 110). Polaroid’s book on preservation has been another helpful step in the right direction. Useful as the book is, however, it is somewhat disconcerting that the majority of information on the stability of Polaroid materials has been published by Polaroid itself. As a manufacturer seeking profit, Polaroid is prone to portraying its products as more reliable than they actually are. This dilemma highlights the need not just for more research on the stability of instant materials, but specifically for more outside research geared towards objective critical scrutiny. Such independent research could challenge Polaroid and its competitors to produce longer-lasting products while, at the same time, advance the field of preservation.

[image removed]

Basic structure of instant integral color film (Harris)

[image removed]

[image removed]

Cracking and yellow staining in an integral color print (Wilhelm and Brower 31)

[image removed]

The long-term effects of dark storage and display on SX-70 prints. The top image was exposed to fluorescent lighting for eight years while the bottom print was kept in dark storage during the same period (Duffy, 22).

[image removed]

Liza Minnelli, 1977 Polaroid photograph by Andy Warhol ("Andy Warhol")

[image removed]

Untitled self-portrait by Lucas Samaras using Polaroid SX-70 film ("Lucas Samaras")

[image removed]

Processing of instant film (Harris)

[image removed]

A few of the instant materials produced by Polaroid (Kuhn)

[image removed]

Coating a black and white instant print (Duffy, 13)

[image removed]

A black and white print before and after selenium toning (Duffy, 38)

Cover image (McCann and Ruzdic back cover)

Works Consulted

"Andy Warhol Photographs, Polaroid Celebrities." ICP.org. 1995-2004. International Center of Photography. 30 Oct. 2004 <http://www.icp.org/exhibitions/warhol/polaroid_celebrities.html>.

Bloom, S. M., M. Green, M. Idelson, and M. S. Simon. "The Dye Developer in the Polaroid Color Photographic Process." The Chemistry of Synthetic Dyes. Ed. Krishnasami Venkataraman. Vol. 8. New York: Academic Press, 1978. 331-87.

Brown, Barbara. Personal interview. 18 Oct. 2004.

Deane, R. J. H. "Notes On the Archival Suitability of Some Contemporary Photographic Materials." ICCM 5.3-4 (1979): 29-35.

Duffy, Pamela, ed. Storing, Handling and Preserving Polaroid Photographs: A Guide. Boston: Focal Press, 1983.

Fitzgerald, Brian. "Polaroid Collection Documents Dramatic Impact of Instant Imaging." B. U. Bridge: Boston University Community's Online Newspaper 15 Nov. 2002. 24 Oct. 2004 <http://www.bu.edu/bridge/archive/2002/11-15/arts.htm>.

"Five Standard Types of Color Photographs." Cycleback.com. n.d. 24 Oct. 2004 <http://www.cycleback.com/colorphotos.htm>.

Freeman, Michael. Instant Film Photography - A Creative Handbook. London: MacDonald & Co., 1985.

Harris, Tom. "How Instant Film Works." Howstuffworks.com. 1998-2004. HowStuffWorks, Inc. 24 Oct. 2004 <http://entertainment.howstuffworks.com/instant-film.htm/printable>.

Hendriks, Klaus B. "Care of Colour Photographic Materials." Canadian Conservation Institute Notes 16/5. Ottawa: Canadian Heritage, 1996.

Keefe, Laurence E., Jr. and Dennis Inch. The Life of a Photograph: Archival Processing, Matting, Framing, and Storage. Boston: Focal, 1984.

Kuhn, Martin. "The Land List Film Index." The Land List. 1992-2004. 17 Oct. 2004 <http://www.rwhirled.com/landlist/landfilm.htm>.

Lavedrine, Bertrand. A Guide to the Preventive Conservation of Photograph Collections. Los Angeles: Getty Publications, 2003.

Leavitt, Don. "Instant Photography." Popular Photography. Dec. 1978: 92+.

Leavitt, Don. "Two Publications Deal With Preservation of Polaroid Prints." Popular Photography. Nov. 1983: 36+.

Lester, Peter. "Instant Immortality." British Journal of Photography. 134.29 (17 July 1987): 826-28.

"Lucas Samaras." Getty.edu. 2004. The J. Paul Getty Trust. 30 Oct. 2004 <http://www.getty.edu/art/collections/bio/a3793-1.html>.

McCann, John J. and Victoria Lyon Ruzdic. “The Large-Format Polaroid Process.” A Masterpiece Close-up; the Transfiguration by Raphael. Cambridge: Fogg Art Museum, 1979. 25-31.

Nadeau, Luis. “Polaroid Land Process.” Encyclopedia of Printing, Photographic and Photomechanical Processes. Vol 2. New Brunswick, Canada: Luis Nadeau, 1989.

Nishimura, Doug. “Polaroid Prints.” Online posting. 27 Sept. 1993. Conservation DistList Archives. 24 Oct. 2004 <http://palimpsest.stanford.edu/byform/mailing-lists/cdl/>.

Norris, Debbie Hess. “The Painter-Photographer: The Photographic Works of Thomas Eakins and Andy Warhol.” The Imperfect Image; Photographs – Their Past, Present, and Future: Conference Proceedings. London: Centre for Photographic Conservation, 1992. 62-68.

Pigniolo, Loren Charles. “Polaroid Prints.” Online posting. 27 Sept. 1993. Conservation DistList Archives. 24 Oct. 2004 <http://palimpsest.stanford.edu/byform/mailing-lists/cdl/>.

Polaroid.com. 2004. Polaroid Corporation. 17 Oct. 2004 <http://www.polaroid.com/index.jsp>.

“Procedures for Preparing Photographs.” Texas Archeological Research Laboratory. 12 July 2001. 24 Oct. 2004 <http://www.utexas.edu/research/tarl/curation/photoprep.html>.

Ritzenthaler, Mary Lynn, Gerald J. Munoff and Margery S. Long. Archives and Manuscripts: Administration of Photographic Collections. SAA Basic Manual Series. Chicago: Society of American Archivists, 1984.

Rogers, H. G., M. Idelson, R. F. W. Cieciuch, and S. M. Bloom. "Light Stability of New Polaroid Colour Prints." The Conservation of Colour Photographic Records. Proceedings of a Symposium Held in London on September 20, 1973. Monograph 1. Ed. A. G. Tull. London: The Royal Photographic Society of Great Britain, 1974. 33-37.

Sieber, Werner. “Re: why does a picture polaroid look different then (sic) a35mm (sic) picture??” Online posting. 17 May 1999. 24 Oct. 2004 <http://www.madsci.org/posts/archives/may99/927059142.Ot.r.html>.

Sofen, Stephen. “Instant Imaging.” IS&T’s 50th Annual Conference: A Celebration of All Imaging. Cambridge: Society for Imaging Science and Technology, 1997. 233-39.

Walworth, Vivian K. "Color Photography, Instant." Encyclopedia of Chemical Technology. Executive ed. Jacqueline I. Kroschwitz and ed. Mary Howe-Grant. 4th ed. Vol. 6. New York: Wiley, 1992. 1003-48.

Wilhelm, Henry. “Color Photographs and Color Motion Pictures in the Library: For Preservation or Destruction?” Conserving and Preserving Materials in Nonbook Formats. Allerton Park Institute. Ed. Kathryn Luther Henderson and William T. Henderson. Urbana-Champaign: University of Illinois Graduate School of Library and Information Science, 1991. 105-11.

Wilhelm, Henry. “Monitoring the Fading and Staining of Color Photographic Prints.” Journal of the American Institute for Conservation. 21.1 (1981): 49-64. JAIC Online. 2001. American Institute for Conservation.

Wilhelm, Henry and Carol Brower. The Permanence and Care of Color Photographs: Traditional and Digital Color Prints, Color Negatives, Slides, and Motion Pictures. Grinnell: Preservation Publishing, 1993.