Conservation of 1950s black and white photographs affected by cellulose acetate off gassing and adhered by rubber cement

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ABSTRACT

The photograph albums (2) of the House of Speedo® document the planning, construction and official opening of the new Speedo mill in Sydney in 1955-56. The album was produced by Vistatone (Australia) Pty Ltd. These albums were used as a frequent show and tell during museum collection tours. Recently it was noticed that they were rapidly deteriorating and were sent to the Conservation department for treatment.

The conservation work involved stabilizing the photographs, removal of the rubber cement adhesive and rehousing the photographs into an archival album.

The House of Speedo® Album cover is composed of an artificial leather cloth fabric such as Rexine® which contains cellulose nitrate. The plastic sleeves with plasticizer were identified by Fourier transform infrared (FTIR) with Universal attenuated total reflectance (UATR) accessory as cellulose acetate and the plasticizer as tri butyl phosphate (TBP), the latter of which was pooling on the front surface of the photographs. There were significant signs of deterioration of the plastic components such as warping and discolouration, as well as acidic off gassing from both the cellulose nitrate and cellulose acetate.

Keywords Black and white photographs, cellulose acetate, rubber cement, vinegar syndrome

THE ORIGINAL COMPONENTS:

The album cover is composed of an artificial leather cloth fabric made from cellulose nitrate, pigment, plasticiser and other additives e.g. Rexine®. The cellulose nitrate coating is colored by mixing powdered pigments with synthetic oils and is applied in several layers, each being dried before the next application. Polyvinyl chloride may also be used in the coating. Embossing is done with engraved steel rollers, usually to imitate the grain pattern of leather, but sometimes with modern geometric designs. This type of cloth has been in use since the first decades of the 20th century.

The plastic transparent sleeves were composed of cellulose acetate with plasticizer tri butyl phosphate (TBP). The sleeve's edges were bound by a white self-adhesive tape. These sleeves were distorted and warped by shrinkage of the cellulose acetate and had a strong smell of acetic acid (Figure 1). The liquid plasticizer had migrated to the surface of the sleeves.

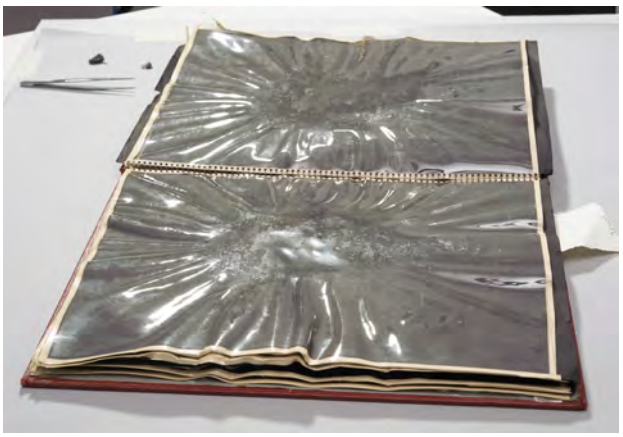

Figure 1. Original condition of cellulose acetate sleeves

Black and white photographs on fibre based paper were adhered by rubber cement onto black backing board. The wet plasticizer had migrated onto the surface of the sleeves and was pooling on the surface of the photographs.

IDENTIFICATION OF MATERIALS

METHOD

Fourier Transform Infrared (FTIR) Spectroscopy with Universal Attenuated Total Reflection (UATR)

FTIR spectrometer with UATR attachment enables non-destructive analysis. This system offers a straightforward analysis of most materials with a minimum of sample preparation. The technique works by the internal reflection of infrared beams through a high refractive index optical crystal and requires intimate contact between the crystal and the surface of the sample. The UATR used in this analysis was equipped with a diamond crystal. FTIR UATR Spectra (30 scans over 4000-650cm-1; 8cm-1 resolution) was obtained using a Perkin Elmer Spectrum 100 spectrometer UATR accessory with Spectrum V6 Software and 3 additional reference libraries. Perkin Elmer Plastics Library; FDM FTIR Spectra of Polymers and polymer additives (580 spectra) and IR Hummel Industrial Polymers, Vol 1 (1,900 spectra). Each material was analysed and their FTIR spectrum obtained and compared to the reference libraries. The best match with high correlation coefficients for the visible absorption peaks was determined. Cellulose nitrate, cellulose acetate, tri butyl phosphate and rubber cement were identified by the FTIR with UATR attachment spectrometer (Figure 2)

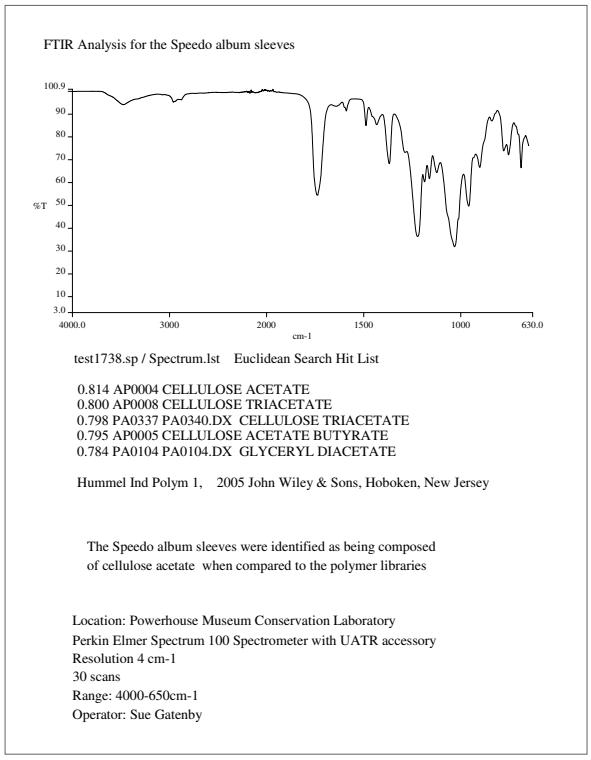

Figure 2. FTIR scan for cellulose acetate album sleeves

THE PROBLEMS PRESENTED

Although cellulose nitrate is present in the composition of this album cover, it is probable that the cellulose nitrate is only contributing to the level of acidic off gassing. It is likely that the cellulose acetate is a significant contributing factor to the damaging environment that the photos are exposed to, as the photographs were in direct contact with the cellulose acetate sleeves, A-D (acid detection) strips developed by the Image Permanence Institute (IPI) were placed between and inside the sleeves. The AD strips gave a positive result for cellulose acetate deterioration and the characteristic vinegar odour was evident. The sleeves were also distorted and warped. The TBP plasticizer had migrated to the surface of the cellulose acetate sleeve and was pooling onto the front surface of the photographs (Figure 3).

Figure 3. Visible plasticizer on the surface of the photo

Cellulose acetate film is susceptible to a slow form of chemical decay known as vinegar syndrome. This decay process causes the plastic film base to become acidic, to shrink and distort caused by the leaching of the plasticizer, and off gassing with the characteristic vinegary odour of acetic acid.

The rubber cement adhesive has caused yellow staining on the front of a small number of photos. In some cases the adhesive has failed and the photos are loose inside their sleeves.

TREATMENT

All photos were mechanically removed from the original album and their backing boards.

REDUCTION OF ACID CONTENT OF PHOTOS

Initial pH measurements of the photograph backs were 5.5 (Oakion pH meter with a surface electrode). The photographs were then sandwiched between layers of Bainbridge Alphamat ® ArtcareTM board with MicroChamber ®Technology[1] boards (buffered acid free mount board containing SPZ zeolites) with a separation layer of acid free buffered paper. AD strips were also dispersed throughout the layers (Figure 4). Photos were placed into a prawn crate which was then put into a fume cabinet for a period of 4 weeks (Figure 5) to assist with the reduction of the acid levels. Weekly pH checking was carried out until the photos measured pH7 and the AD strips remained pH neutral.

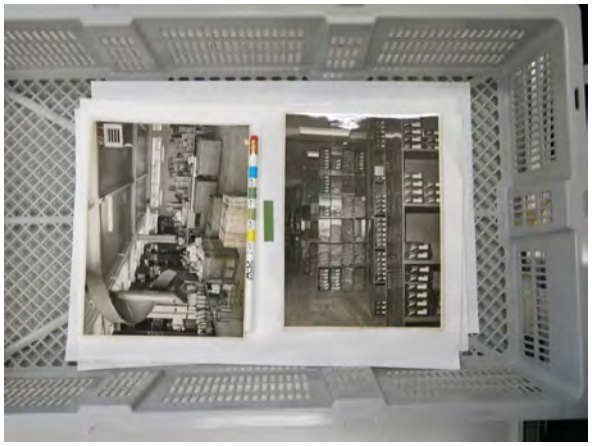

Figure 4. Positive AD strip test for photos

Figure 5. Airing of photos

REMOVAL OF PLASTICIZER FROM PHOTO SURFACE

Tri butyl phosphate is a common plasticizer used with cellulose acetate.

The plasticizer was removed from the photo surface using petroleum spirit swabs. If the plasticizer was allowed to dry it became more difficult to remove using this method.

System/Solvent tested	Result	Comment
Shaved gum eraser	No change	Unsuccessful
Distilled water	Removed remnants of black backing board and surface dirt	Used to reduce amount of deposits on back of photos
Petroleum spirits	No change	unsuccessful
ethanol	No change	unsuccessful
4% Klucel in ethanol (v/w)	Significant change	reduced stained area

Table 1. Solvent testing for the removal of rubber cement adhesive.

RUBBER CEMENT ADHESIVE REMOVAL

Rubber cement was a common adhesive previously used to attach photos onto their backing boards. It was a convenient way to stick collages and photos or paper without distortions caused by water based adhesives. Within a short period of time, rubber cement becomes yellow staining the paper or photograph, and then it turns brittle, completely losing its adhesive quality. Rubber cement is a poor choice for use with photographs since it contains sulphur which can chemically react with the silver image particles in typical 20Th century photographs. Some of the images have yellow/brown coloured staining which is visible on the front of the photographs.

A number of different solvent solutions and gum erasers were tested for the removal of rubber cement. The results are outlined in Table 1.

The best result was found using the 4% Klucel in ethanol (w/v). The Klucel G acted as a paste and allowed the ethanol to sit of the surface of the rubber cement adhesive. This allowed softening of the rubber cement adhesive, which could then be removed by cotton swabs. This treatment reduced the bulk and staining of the rubber cement and lessened the yellow staining.

TREATMENT PROCEDURE

Initially distilled water swabs removed the remnants of the black backing board and some dirt. It was very important to remove as much of the black backing board residue with mechanical action and scalpel scraping before the application of the Klucel G 4% in ethanol. The Klucel solution was applied using cotton swabs and after its application, a swab of distilled water was used to rinse the surface of the Klucel. After this treatment was a visible reduction in the rubber cement staining (Figure 6). The photos also required flattening between blotting paper and light weights.

STORAGE

The photos were hinged using photo corners onto the new backing boards. An Albox archival A3 album with polyethylene sleeves and black acid free paper board was selected. The Albox album matched closely with the size of the original Speedo Album. The black board was chosen because the original album had black backing boards and it was desirable to replicate the original album colour theme. Albox covers and photo pages have passed the photographic Activity test (PAT) of the Image Permanence Institute and the National Archives of Australia (Figure 7).

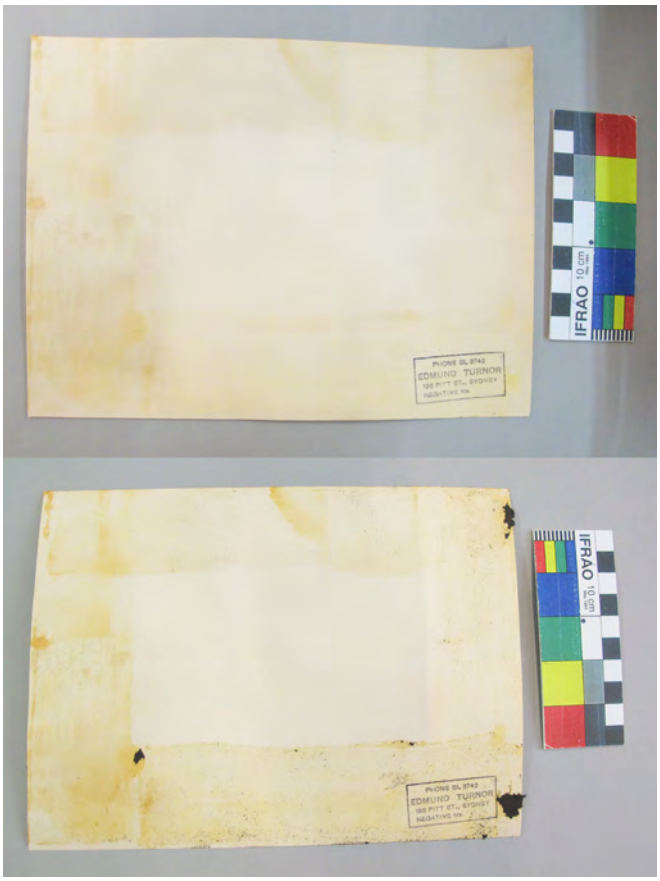

Figure 6. Before and after treatment of rubber cement removal. Top photo is after treatment: bottom photo before treatment

Figure 7. photos hinged in new archival Albox album

DISCUSSION

The airing and sandwiching of the photos with Bainbridge Alphamat Artcare ® mounting board with zeolites, reduced the level of acid to a neutral pH7. There were no remaining acid residues in the photos. The rubber cement proved difficult to remove. The remnants of the black backing board and dirt were removed by mechanical action and with distilled water swabs. Numerous solvents were tested to remove the rubber cement adhesive staining on the back of the photos. Physical attempts with a wooden probe and scalpel were unsuccessful. Klucel G 4% in ethanol was recommended by Laura Wahl who had similar problems with rubber cement adhesive on the back of photographs [1]. This treatment was successful in reducing the bulk of the rubber cement adhesive and staining. The wet plasticizer was removed using petroleum spirits, but once it was dry it was more difficult to remove.

There was no way to retain the original method of storage. The original album and sleeves were stored separately in cold storage with Bainbridge Alphamat ® ArtcareTM board with MicroChamber ® interleaving and placed into a cold storage freezer.

After the completion of the conservation treatment, these photographs were transferred into an Albox archival album and polypropylene sleeves and hinged onto black archive paper. In its new storage album, with conserved photographs, the album could then be returned to the basement store and be used again for basement tours.

This project highlights the rapid deterioration of cellulose acetate sleeves used in this Album. Cellulose acetate based objects were extensively produced between 1928 and the 1970's. The vinegar smell (Acetic acid) also known as vinegar syndrome is generally an indicator of deterioration and can become significant in as little as 24 hours. Another common sign is the warping of the plastic caused by the leaching of the plasticizer.

CONCLUSION

The photos from the original *House of Speedo* album were stabilised, acid content reduced to pH7 and stored in a conservation archival Album and polypropylene sleeves with black acid free paper board which was PAT approved and tested. The rubber cement staining was reduced by mechanical cleaning and with Klucel 4% in ethanol swabs. The tri butyl phosphate plasticizer was removed using petroleum spirits.

ENDNOTES

1. Wahl, L e-mail communication 24/10/2013.

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James Elwing: for significant involvement in this project when employed by the Conservation Department at the Powerhouse Museum and later, for advice, as a Book and Document conservator in private practice.

MATERIALS

A-D (acid detection) Strips-
Developed by the Image Permanence Institute (IPI)
Archival Survival
PO Box 1139, Doncaster, Victoria. 3108
www.archivalsurvival.com.au

Bainbridge Alphamat ® ArtcareTM board
(Buffered acid free mount board containing SPZ zeolites
Megawood Mouldings Pty Ltd
931 Nudgee Road, Banyo, Qld. 4014
www.megawood.com.au

ALBOX A3 Archival photographic albums: polypropylene A3 sleeves: acid free board.
www.preservationaustralia.com.au

Klucel G® hydroxypropyl cellulose chemical and physical properties handout
www.archivalsurvival.com.au

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Sue previously worked at The Australian Museum as an ethnographic conservator with special interest in indigenous painted surfaces and mould related issues. Recipient of ESSO and UNESCO scholarships to undertake further conservation training and studies at ICCROM, Rome and the Getty Conservation Institute.

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