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Author(s): Caitlin Granowski, Andrea Wise, Christopher Drover and Zbigniew Stachurski
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A PRELIMINARY INVESTIGATION INTO ACRYLIC GLAZING DETERIORATION

Caitlin Granowski, Andrea Wise, Christopher Drover and Zbigniew Stachurski

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Abstract

The National Gallery of Australia (NGA) has a successful and wide ranging travelling exhibitions programme enabling works of art from the National Collection to be seen in Australian State and Regional galleries and in galleries in the wider Asia Pacific region. Over the past few years paper conservation staff at the NGA have become increasingly concerned by what appears to be the breakdown of acrylic glazing used in frames for photographs and works of art on paper in these exhibitions. This study is particularly focussed on discussing the various forms of observed deterioration and initial experimental work which has been undertaken in an attempt to simulate this phenomenon, understand the mechanism at work and to ascertain if it is of a physical or chemical nature. Whilst not as successful as hoped, the experimental regimen used will form the basis of further research into this problem. It is believed that vibration, exposure to higher than recommended levels of relative humidity (RH) and possibly even heat are factors in catalysing this effect, and that surface to surface contact between the work of art and the mount with the interior of the glazing is required.

Introduction

The NGA has a successful and wide ranging travelling exhibitions programme enabling works of art from the National Collection to be seen in Australian State and Regional galleries and in galleries in the wider Asia Pacific region. The NGA has approximately seven travelling exhibitions touring at any time and usually 85% of all works travelling are works of art on paper. Those travelling exhibitions not exclusively drawn from the works of art on paper collections are commonly a combination of works on paper and paintings. This includes photographs, prints, drawings, watercolours, books and folios. Approximately 90% of the paper based works sent in these exhibitions are displayed in standard wooden frames with acrylic glazing. Over the past few years paper conservation staff at the NGA have become increasingly concerned by what appears to be the breakdown of such glazing. Physical and anecdotal evidence suggests there are two to three distinct patterns of deterioration, one of which is directly affecting the works of art housed within the confines of the frame.

Observed Types of Acrylic Glazing Deterioration

Crazing

Communication with staff at other cultural institutions, together with a record of our own observations has provided evidence of various changes to acrylic glazing whilst in, or after, use. There have been reports of a spider-web like crazing across the surface of the sheet. This phenomenon may occur across the sheet which is in contact with the window mount leaving the area over the work free of crazing; however it has also been seen to affect the area of the sheet which is over the work leaving the area in contact with the window mount free of crazing.

Stress Cracking

A similar problem, though with a completely different effect, is what appear to be stress fractures across the body of the acrylic sheet. These generally are condensed along two sides and work their way to the middle, becoming fewer the closer toward the centre they are. The pattern suggests that flexion due to cutting or shock would cause such marks, however examination of the surface using a stereo microscope shows that the ‘fractures’ are not linear across the surface. Rather, they twist and change direction forming ‘Y’, ‘X’ and feathery lines. Simple microscopic examination revealed an intricate system of lines, grouped and in isolation from each other. Examination by raking light showed a slight topography to the surface of one side of the sheet, which created a rippling effect in the light.

White Deposits (Acrylic Disease)

Another type of deterioration has an apparently complex mechanism and results in deposits of a white particulate nature forming both on the inside of the glazing and the surface of the framed work. It is this form of deterioration, known colloquially as *acrylic disease*, which staff in the NGA paper conservation section are particularly interested in as it has had a direct, sometimes irreversible, impact on framed works of art.

Poly(methyl methacrylate) (PMMA)

PMMA is a member of the acrylate polymer family, and the term acrylic is often used to identify materials based on the PMMA composition. Acrylic is used extensively for cultural heritage purposes, in both cast and extruded form, for object supports, display cases, tools and glazing. PMMA is produced by numerous international manufacturers, all of whom develop a product marginally different to their competitors. As such, PMMA can be found under many varying trade names according to the specific recipe of manufacture. Examples include Plexiglas (Degussa Röhm & Haas), Perspex (ICI), Shinkolite (Mitsubishi Rayon), and Lucite (Lucite International). One source lists over forty trade names (Smith, 1998).

Pure PMMA is a carbon-chain homopolymer formed via the free-radical polymerisation of its only monomer, methyl methacrylate (MMA) (Budinski and Budinski, 2004). However, the chemical composition of commercially available PMMA products can be highly variable, often reflecting the large number of additives that are incorporated into the mix prior to formation of the sheet. The additives both bulk and alter the PMMA composition hence its characteristics will vary when comparing acrylics of either a different brand or application (Röhm, 2006). PMMA can be produced in sheet form by either casting or extrusion and this will also affect its inherent characteristics.

The Use of PMMA in Museums and Galleries

The acrylic sheet used for museum purposes exhibits uniform UV filtering, as well as advanced scratch and static resistance, rigidity and optical transparency. The use of PMMA in sheet form for glazing in picture frames is presently one of the most common applications of the material. In Australian galleries and museums, it has largely replaced glass as glazing for frames due to a number of distinct advantages. With respect to glass, PMMA provides an equivalent level of optical transparency, enhanced UV filtering capabilities, is shatter resistant and lighter in weight. These facts are of particular importance to museum staff where the prime concern has been to ensure that framed works of art are safer to handle and protected from the risk of impact damage.

Chemical Stability of PMMA

PMMA in acrylic sheet form is also regarded as being extremely chemically stable, a necessary attribute considering its multiple applications within the museum environment. However it appears that PMMA may not be as benign as originally thought and, as with other plastics, it is necessary to consider that PMMA can potentially be affected by a range of factors, including light, ultraviolet light, chemicals, vibration, stress and changes in RH and temperature. Degradation processes, in general, can lead to a range of alterations such as darkening in colour, crazing, embrittlement, blooming and softening of plastics. (Morgan, 1993).

PMMA is capable of a two-step depolymerisation process. The first of these steps is a monomer volatilisation mechanism, initiated at the unstable terminal groups present in some of the macromolecules. The second step is due to the depolymerisation of the radicals resulting from the random scissions of the polymer chains, occurring for temperatures beyond 300°C (Chlantore and Gualta, 1988). Also, bond scission in PMMA is possible at temperatures as low as 165°C. This occurs due to the generation of unstable units during termination reactions of PMMA radical polymerisation (Chlantore and Gualta, 1988). Thermal degradation of PMMA is thought to be rare in practice, as the majority of its many applications do not see it exposed to such destructive conditions. There is however a possibility that the additives present in PMMA may respond to elevated temperatures and/or RH. Potentially this may facilitate the release of PMMA from the polymer chain. It is known that at least one form of acrylic sheet used as glazing by the NGA is susceptible to breakdown. This is believed to result from interactions between the acrylic, the work of art and the environment.

Incidences of *Acrylic Disease* with NGA Travelling Exhibitions

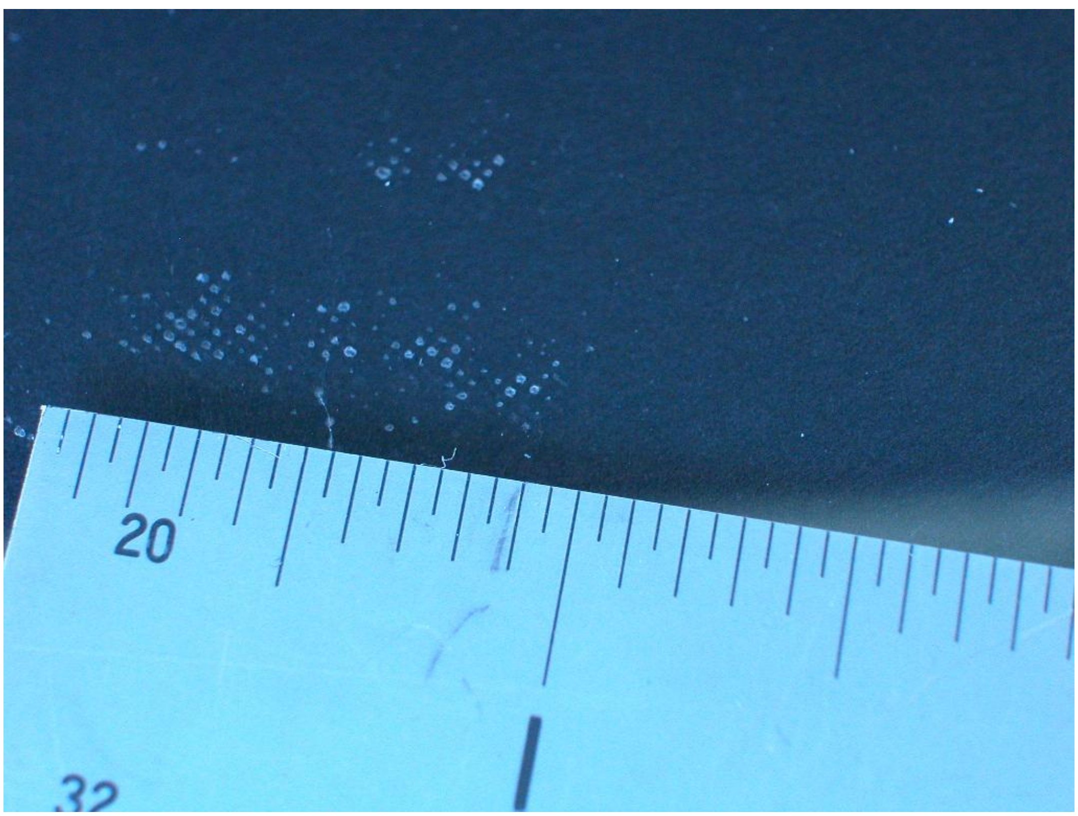
Some framed photographs and works of art on paper in NGA travelling exhibitions glazed with acrylic had developed areas of a white deposit on their surface during the scheduled tour. When first discovered on a group of large silver gelatine black and white photographs by Yousuf Karsh, it was thought that the works had suffered some sort of mould growth. Prior to exhibition at the next venue, these works were unframed and both the surface of the emulsion layer and glazing were cleaned. At the final exhibition pack up, three months later, the white deposit was found to have reformed in the same areas on these works.

Detail of black and white silver gelatine photograph by Yousuf Karsh, with white deposits on the surface of the photograph and on the interior surface of the acrylic glazing

On return to the NGA the effect on the work and glazing was carefully documented and samples from each surface were taken. It was noted that the marks on the work corresponded exactly to marks on the glazing. To the eye, the white bloom had a dense furry characteristic and was relatively easy to remove from both the surface of the work and the glazing. The process of taking samples for analysis revealed a different character - the deposit seemed waxy, clumping on the surface of the work and some times adhering itself to the acrylic, seemingly embedded in it. The surface of the works were cleaned using a swab dampened with 50/50 ethanol/water or occasionally a molecular trap (*Groomstik*); but the surface of the acrylic posed a more difficult cleaning proposition as smearing was difficult to eliminate.

Soon after this occurrence, a similar white deposit was observed on a number of screenprints by Andy Warhol from the collection in an NGA travelling exhibition. On one set of prints the deposit was more difficult to remove. The prints with a glossy ink surface could be cleaned using a molecular trap, but those with a very matt ink appeared to have the deposit embedded in the surface. The surface of the acrylic was also difficult to clean and examination of the glazing revealed an etched effect. It appeared that in each case, the glazing had been in contact with the surface of the work at the point where the white deposit formed. Another curious observation was that the white deposit on these works, in more than half the recorded incidences, formed on the interior of the glazing and the surface of the work, in a pattern corresponding exactly to the dots of the screenprinted image. More often than not it was also noted that the deposit formed in black areas of screenprinted ink.

One instance which stands out involves most of the works of art in one particular NGA travelling exhibition. Of the ninety works, seven had been directly affected with white deposits forming on the surface of the works, while the remainder had instances of the deposit developing on the window mounts. This exhibition had been travelling for about a year, but it appears that the deposit can form in a relatively short period of time as it has been recorded as recurring on cleaned works within the space of three months.



White deposits on the acrylic glazing removed from the frame previously used for an Andy Warhol screen-print - the pattern of dots corresponds exactly to the image

Suggested Contributing Factors for the Deterioration of Acrylic Glazing at the NGA

Cleaning Methods and Materials

Initially, NGA paper conservation staff were puzzled by what appeared to be a phenomenon peculiar to the Gallery, and so glazing cleaning processes were examined. Antistatic acrylic cleaner and a 50/50 mix of methylated spirits and water, applied in minimal amounts using an atomiser and dried using lint-free paper towel, had been used to prepare all acrylic glazing for every exhibition. Samples of cleaning fluids were evaporated on glass slides and examined using Fourier Transform Infra-Red spectrometry (FTIR) analysis. No significant residual material was discovered. The cleaning methods and materials are similar to those used in numerous other institutions and have not varied for many years.

There are conflicting claims in the literature related to the chemical stability of PMMA. In some sources it is rated as having excellent chemical resistance (Horie, 1997; Morgan, 1991). However it should be noted that due to its solubility parameters it could potentially be susceptible to a number of solvents, including some alcohols and white spirits, which are recorded as inducing cracking and crazing (Morgan, 1993). While it is conceded that using methylated spirits and water is probably contributing to the crazing of the acrylic glazing, NGA mountcutting staff have continued to use this method, as the protective covering with which the acrylic sheet is supplied when new, leaves a residue which is difficult to remove with other methods. Currently staff are investigating alternative cleaning solutions for this problem.

A commercial anti-static liquid cleaner, known as *Kunstoff*, is also applied in minimal amounts to clean the acrylic glazing and to reduce the static charge on the surface prior to use. While the full proprietary formula is not known, the materials safety data sheet states that Kunstoff is a colourless, perfumed, aqueous solution of surfactants and isopropanol; it should be noted that the isopropanol component could be a contributory factor in the instance of the crazing. Vulnerability of PMMA to other chemicals has also been proposed, for example Thymol crystals (Boyd & Daniels, 1986). While it seemed reasonable to suggest that cleaning solutions might be the source for the cracking and crazing, the questions surrounding the white deposits remained unanswered. The fact that the deposits were a reasonably recent occurrence and only occurred on the framed works which were travelling for extended periods seemed to indicate that cleaning methods were not the significant contributing cause.

The Environment

Acrylic sheet also appears to be reactive to changes in RH and/or temperature, as anecdotally evidenced by the framer's practice of cutting the glazing smaller than the frame rebate so to allow expansion of the sheet without *popping* the frame. Expansion and contraction of PMMA in response to the moisture content of the air is also recorded in the available literature (Harper, 1975). Climatic variation was considered a contributing factor; it had to be acknowledged that although the travelling exhibitions organised by the NGA are subject to international conservation parameters whilst in transit, in reality the works travel throughout the Asia Pacific Region with the potential to be exposed to widely varying climatic conditions. Tracking and monitoring of the exhibitions in transit revealed that the white deposit, *acrylic disease*, usually formed in one of the more southerly Australian venues (temperate) after exhibition in a more northerly venue (tropical) where the RH is consistently high.

Inspection of the glazing surface of affected works generally revealed clear signs of abrasion where it had been in contact with the window mount. The marks appeared as a stucco type pattern, regular and close together, indicative of some sort of vibration. Evidence of abrasion was not surprising as framers have reported that the properties of acrylic sheet supplied over recent years had changed. Anecdotally it has been reported that the acrylic sheet seems to be more difficult to clean, the surface is softer and easily marked, a sheet buckles under its own weight and its visual aspects (such as cloudiness) may vary.

Until recently the authors were aware of only one other report on acrylic glazing deterioration, from a cultural institution in the United States. The report was of small deposits of white powder on the surface of works on paper, including the mounts. When this was first noticed, it was assumed to be mould, but upon further examination the powder was found to be *a powdered acrylic dust*. These powder samples were tested and found to have the same melting point as acrylic glazing. When examining the sheet in question, it seemed to have deteriorated in a particular way. The areas of the glazing relating to the powder deposits appeared to have been *scooped out as if with a mini-melon ball scoop*, rather than having the appearance of scratching as might be expected. There was some discussion of an adverse interaction between the paper, the media and the glazing, however it was found that the phenomenon developed with a variety of media (plain paper, printed surfaces, photographic surfaces as well as watercolour and gouache). The most obvious common factor between all instances was vibration as the first incidence was seen on works that had been included in circulating exhibitions. Later on, a large work that had never travelled was discovered to have the same problem, but it was also noted that the work had been stored for years in a store room which is over a subway. Years of vibration from the train tracks seems to have caused the same result as truck travel.

The American institution found the deposits were simple to remove with a brush, revealing on occasion that the media underneath had been burnished or abraded. They discovered that the deteriorated areas on the acrylic could not be simply wiped clean, as the whitish deterioration was still visible proving that there is actual physical damage to the acrylic rather than an accumulation of dust. Moreover, they observed this phenomenon on acrylic glazing from various suppliers and with different ultraviolet filtering capabilities. They too wondered if their cleaning fluid for glazing might be to blame. Interesting, the authors recently came across an unpublished Australian student research project (Smith, 1998) investigating the effects of cleaning solutions on acrylic glazing on behalf of an Australian art institution where there had been problems with acrylic glazing deterioration.

Sample Analysis and Discussion

The initial results from FTIR analysis on the NGA Karsh samples were thought to be contaminated and thus inconclusive. A second sample was taken from the photograph and interior of the acrylic glazing, and analysed by FTIR and Scanning Electron Microscopy-Energy

Dispersive X-ray Analysis (SEM-EDXA). Results from FTIR indicated pure poly methyl methacrylate (PMMA), and the SEM spectra revealed a sodium peak, which by all accounts seems strange. Postulations of an additive like silicon or a surface coating (such as UV) contributing to the problem were made; on contacting the manufacturers it was implied that it is not possible for sodium to be leaching from framing grades of acrylic glazing and that there had been no change in the recipe over the last few years. They did concede, however, that *acrylic is not acrylic* and that grades are different and manufacturers have different recipes. For example, an impact modified acrylic may produce a sodium peak - unlikely but possible. There was some discussion that if the basic recipe had not changed then perhaps there may have been a percentage of recycled material used in manufacture; again, this was not accepted as a possibility by the manufacturers.

Samples from an Andy Warhol screenprint were taken and sent, along with a piece of the affected acrylic, to two independent international laboratories for confirmatory analysis - an acrylic manufacturer in Germany and a cultural institution in the United Kingdom. The German laboratory commented that the acrylic looked quite yellowish, particularly at the edges, something NGA paper conservation staff had noticed in many cases. They suggested that the reason for this could be a surface coating or a substandard plastic material. On analysis of the acrylic sample, they verified that it was not their product. Further to this, they stated that sodium could not be created by their museum glazing product line, and hypothesised that it was an external factor such as dirt or the work itself as the source of the deposit.

The UK institution, where similar problems with acrylic glazing deterioration had been observed, used Raman spectroscopy on the NGA acrylic sample, comparing it with a standard reference acrylic sample. They noted that there were some small differences between the two spectra which might have been attributable to a UV coating or flame retardant in the NGA sample. It was also suggested that changes in the properties of the sample, undetectable to the eye, could cause additional bands in the spectrum. Examination of the affected areas of the sample appeared as:

> *…pronounced fine-grained white deposits, [and] produced spectra with a very similar profile to that obtained from the unaffected areas of [acrylic]. This indicates that the whitened areas on the [acrylic] are composed predominantly of polymethyl methacrylate and not of an entirely different material derived from the work of art. Again, small differences are observable between the spectra obtained from the affected and unaffected areas of the [acrylic]. These differences indicate that although the affected areas on the [acrylic] are certainly derived from the polymethyl methacrylate, their composition is slightly different to the unaffected [acrylic]. Thus, the [acrylic] has undergone some kind of polymer degradation in the affected areas. However, the cause of this polymer degradation is currently unknown. Further analysis of the affected areas may be used to determine fully the changes that have occurred in the [acrylic] and to establish the cause (such as, light or off-gassing of material from the surface of the work of art) of the changes.* (Chaplin 2005).

Raman materials characterisation was conducted on several samples of deterioration products as well as the corresponding source PMMA sheet. Facilities at the University of Canberra Corrosion and Spectrochemistry Laboratory were utilised for this procedure. All spectra were clearly indicative of a PMMA composition, although several additional reflectance peaks occurred in the deposit spectra, -1 for instance 1232 and 1323cm. These were as a result of an unknown material being present, possibly dirt. Burgio and Clark (2001) present spectra for a reference sample of PMMA. The samples of deterioration products and their source sheet show reflectance peaks at 360, 479, -1 598, 814, 969, 1450 and 1730cm. This characterisation of materials clearly indicates a PMMA composition for the deposits that form on the acrylic surface. It would seem likely that the degradation products of acrylic glazing are derived from within the PMMA sheet itself. Strong reflectance peaks are observed in the spectrum produced by the acrylic sheet, although the signal is often weak for the deposit spectra. This is attributable to the physical structure of the sample, not the chemical composition. The undisturbed surface of the acrylic sheet allows a strong reflectance of the monochromatic light. In contrast, the accretions of deterioration products form a permeable structure, and the reflection from these samples is relatively weaker.

Experimental

Sample Preparation

In a situation where so many potential contributory factors were at work, a decision was made to focus the experimental work on vibration and RH. In an attempt to simulate the observed patterns of deterioration, particularly the white deposits, in the acrylic glazing used in the standard frames for NGA travelling exhibitions, twenty-four sample works were created. These were recently printed, oil based, lino cut works on paper, mounted and framed with the same materials and techniques as those routinely used in the preparation of works for NGA travelling exhibitions. Half the prints were first washed and allowed to air dry to induce cockling and thus the required contact with the interior of the acrylic glazing. The other half were maintained flat, so that contact with the glazing was avoided.

Mounting was carried out using Japanese Kozo paper hinges, attached with wheat starch paste. The window mounts and backboards were prepared from good quality, acid-free, rag mountboard, again taken from the range normally used by NGA Mountcutting staff. Standard NGA Blackwood frames were prepared with two different brands of acrylic glazing, both used by the NGA in the past, and a recycled sheet of unknown brand. The glazing was cleaned using 50:50 methylated spirits and water and Kunstoff anti-static cleaner. The different acrylic sheets were used in the hope of clarifying whether or not the deterioration was specific to a certain brand of PMMA. The sheet of recycled acrylic glazing had previously been used to frame a work by Frank Stella and had already shown signs of deterioration. Assembly of the experimental samples was completed in a clean area. The acrylic glazing was placed in the frame, taking care, in the case of the recycled glazing previously used for the Stella work, to ensure the appropriate surface was facing inwards – the glazing had deteriorated on one side, and therefore the unaffected side was arranged to face the facsimile work. A final backboard of Coreflute was placed in each frame and the assembly sealed with a rubber gasket. Completed samples were placed in the control environment where they were allowed to acclimatise overnight.

Although contact vibration was of initial primary interest, testing of PMMA at elevated RH was also conducted, on the basis that this could potentially influence the initiation of a depolymerisation process. Exposure of the facsimile works to extreme environmental conditions may have facilitated PMMA breakdown, however this was deliberately avoided in order to maintain a close resemblance between the simulated environments and the actual conditions in which acrylic glazing deterioration had been initiated. Another important consideration when designing the experimental samples was the intended rate of atmospheric exchange between the interior and exterior of the frame. Elevated levels of RH produced by the experimental apparatus were to be transferred to the frame's microclimate, thereby replicating a potential environment to simulate deterioration. Increasing the capacity for airflow between the macro and microclimates was achieved via the deliberate inclusion of small gaps in the gasket seal around the frame.

Experimental Equipment and Regime

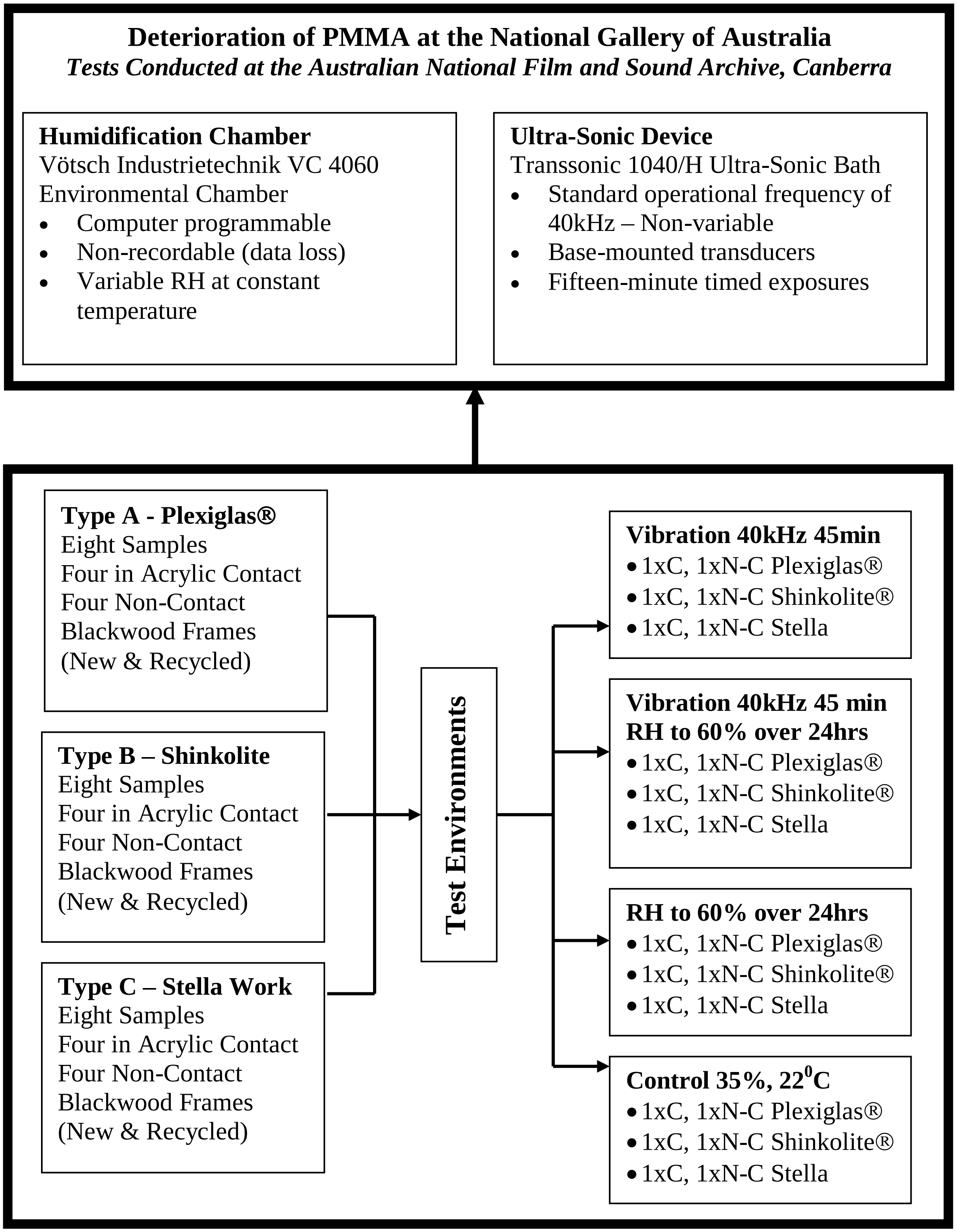
Twenty-four samples were categorised primarily by glazing and secondarily by contact. The samples were divided so that each of the four groups contained two examples of the different glazing types – one in contact with the work of art enclosed, and one without contact. Three groups were exposed to cycling RH levels and degrees of vibration, where one was exposed to vibration for a period, one was exposed to elevated RH for a period, and one was exposed to both simultaneously. The final was the control sample and retained in ambient laboratory conditions.

Vibration

A simple, consistent system of vibration was considered adequate for the purposes of simulating a realistic scenario of applied mechanical energy. The conditions were limited by the operational capabilities of the ultra-sonic device used for the experimental testing, the theoretical frequency of which was 40kHz. In reality some buffering of mechanical energy occurred which will be discussed in the experimental results. This component was designed to deliver the equivalent of 250 hours of vibration at 120Hz, or approximately 250 hours of travel in a non-air ride truck.

Relative Humidity

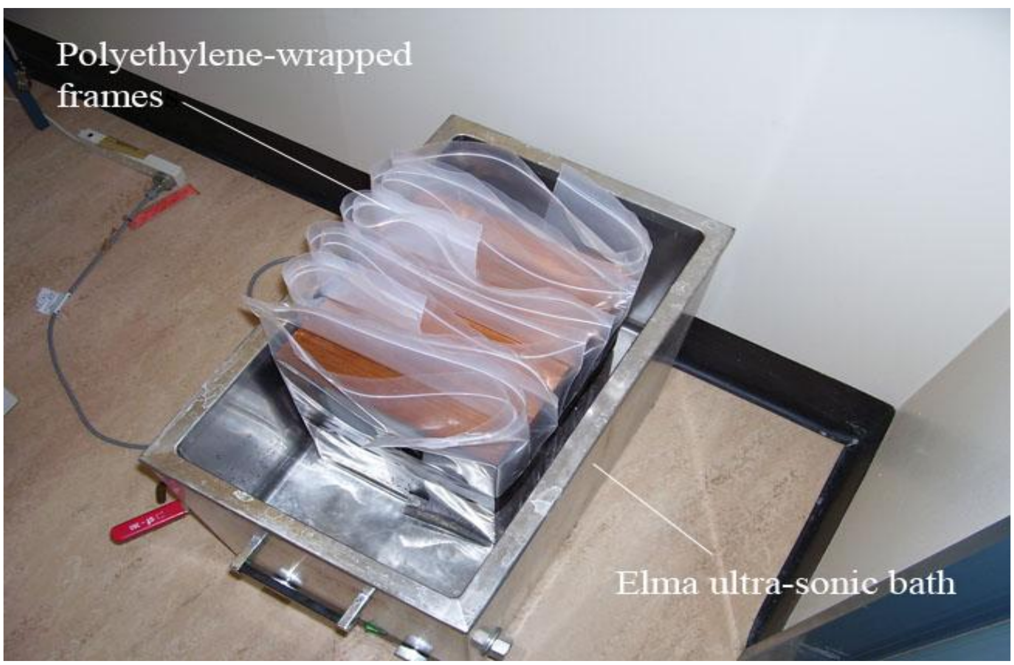
It was the aim of the testing to establish whether deterioration was possible under the set conditions, and to determine if RH played a role. Clearly outside the experimental testing were the specific mechanisms of RH to acrylic deterioration. The RH was set at a maximum of 60% which was considered to be the average high end of exposure an NGA travelling exhibition might experience.



Key: *C=Contact;*
N-C=Non-Contact;
Stella=Recycled acrylic glazing which had been previously used in a frame for a work by Frank Stella

Testing Methodology
The test laboratory at the National Film and Sound Archive (NFSA) in Canberra consisted of three rooms, with each theoretically controlled to 35% RH and 22^{0}C. There were some fluctuations with the air conditioning during the experimental process, but these were considered to have minimal effect on the overall results.

Vibration
A Transsonic 1040/H Ultra-Sonic bath, manufactured by the German company Elma®, was used to simulate vibration. The constant operational frequency of the apparatus is 40kHz, provided by spread-beam transducers mounted under the base plate of the bath. Typically, the bath is filled with water and a small metal base plate distributes ultrasonic vibration. In a trial run it was established that an insufficient level of vibration was being transferred to the samples and the tri-wall cardboard housing used to hold the frames during testing also dampened the vibration. As an alternative the frames were placed in direct contact with the base plate and partly submerged below water level. To avoid water damage, each sample was placed in a heavy-duty polyethylene bag. The bags remained unsealed to avoid the development of a microclimate. The actual vibration of each sample batch was approximately forty-five minutes at a frequency fractionally below 40kHz. On completion the samples were removed from the polyethylene packaging and returned to the control environment.



Ultra-sonic equipment in use - framed facsimiles vibrated for 45 minutes at approximately 40kHz, protected by heavy-duty polyethylene bags

Humidification
A Vötsch Industrietechnik VC 4060 environmental chamber with a computerised control system was used to achieve cycling levels of RH while maintaining a constant temperature. The framed works were placed flat and face up inside the chamber. Over a period of five hours, the RH was increased from 35% (the ambient environment) to 60% where it was held for two hours before being progressively returned over a further five hours to 35%. Throughout, the temperature was maintained at 22^0C ± ~ 0.8^0C.

Combination Testing
Exposing samples to vibration and elevated RH simultaneously involved placing the ultra-sonic equipment in the environmental chamber and repeating the previously described tests.

Controls
Six control samples were stored on a bench in the same labs at the NFSA. They remained undisturbed for the duration of the experimental work.

Results
Unfortunately, none of the experimental testing simulated the desired degradation. In some samples abrasion products were observed on both the acrylic glazing and frame, and there was some evidence of surface damage where the glazing had been in contact with the frame. No surface deposits were formed and the morphology of the damage indicated that it was simply due to abrasion.

Conclusion

The supply of acrylic glazing to the NGA has varied as the frame manufacturer has chosen what he believed to be the best quality on the market at the time. The mechanism for the degradation of acrylic glazing known as acrylic disease has not been determined and is still not completely understood. The sealed frame microclimate is being studied internationally but is a relatively unknown quantity, and it may be that there is a reaction between the media, support and glazing. The NGA has observed this sort of glazing deterioration on black and white silver gelatine photographs, screenprints, etchings, lithographs and oil paintings. Therefore it seems that it is improbable, although not impossible, that the frame microclimate is the catalyst for the deterioration. Conditions required for the development of acrylic glazing degradation appear to include vibration over an extended period of time, and surface contact between the glazing and window mount or work of art. It is suspected that vibration is a major catalysing factor, but that other influences in the environment, such as RH and temperature, cannot be ignored.

Since beginning this study, many more works have been found to be affected by acrylic disease. A New South Wales regional gallery's collection of deeply coloured Ciba-chrome prints have been discovered with white deposits scattered across their surfaces. A commercially framed large work on paper, sent to the NGA in 2001 from America, has white deposits across its raised surfaces. Five oil paintings framed behind acrylic in gilt frames recently returned from travelling with deposits across the gilding, leaving the gilding burnished. There is now high turn over of acrylic glazing which is not an inexpensive consideration. Samples have been taken from the oil painting frames and large print and are being analysed by NGA staff using facilities at the Art Gallery of NSW (AGNSW). NGA paper conservation staff expect that with further study and analysis an understanding of the mechanism causing this deterioration can be gained. With this knowledge, it is hoped that dialogue can be entered into with acrylic manufacturers. If anyone would like to contribute to this research, please contact staff in Paper Conservation at the National Gallery of Australia.

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Caitlin Granowski, private paper conservator, Melbourne
Andrea Wise senior paper conservator at the National Gallery of Australia
Christopher Drover, engineering student, Australian National University
Zbigniew Stachurski, materials scientist, Australian National University

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