NEWS LETTER 14

British Technical Committee, Corpus Vitrearum Medii Aevi

Physics, University of York | 21 April 1975 | Ref. TC/75/5

CONTENTS

1 GENERAL

1.1 DEATH OF THE VERY REVD. ALAN RICHARDSON, KBE, DD.

With the death of the Dean of York on 23rd February we have lost a great friend of stained glass and its restoration. He was a wise, friendly and far-seeing scholar who made at least two highly-significant contributions to the future of restoration techniques. The first was the part he played, together with Lord Kilmaine (then Secretary of the Pilgrim Trust), in setting up the York Glaziers Trust in 1966 and providing it with space fit for the new independent workshop. The second was his wish to understand the requirements of the scientists who wanted to carry out experiments not only on Minster glass but within the building of York Minster itself, to give them encouragement and, above all, to obtain the approval of the Chapter for their work. Without his help we should not have been able to use films to monitor the natural radioactivity of the early medieval glass, nor should we have been able to proceed with the current experiments to study the environment within the cavity of a ventilated, externally-protected window. His memory will long be with us.

1.2 OBJECTS OF THE NEWS LETTERS

It should be clearly understood that these News Letters provide a forum for exchanging current information, recent research results and comments from readers. They are NOT authoritative instructions to restorers having the approval of the CVMA; any experienced restorer who wishes to adopt some practice which is described in a News Letter does so on his own responsibility in the light of his experience. I should have thought that this warning would not have been necessary but cases have recently occurred where inexperienced restorers have embarked on restoration projects which were too ambitious for them, and they quoted these News Letters as their authority!

1.3 ERRATA

I regret that there have been two statements in earlier News Letters which require correction.

1.3.1 Item 183 by Frau Dr Eva Frodl-Kraft

Frau Dr Eva Frodl-Kraft has written to point out a mis-translation of the abstract of her paper. In N.L. No.13, Col.2, second paragraph it is stated that "in 1950, some of the cracked or splintered pieces of glass were plated with an interlayer". This was a mistake and it should have read "without an interlayer". The Bundesdenkmalamt does, of course, forbid any treatment which may change with time or which may affect the paint.

Regarding the glass in the Angel panel at Kremsmünster, which had deteriorated in 30 years after it had been installed the wrong way around, she points out that the inner surfaces of the other panels in the same series, which were re-installed correctly, are perfectly intact. Thus my question (b), as to whether adverse war-time storage might have influenced both surfaces, in such a way that deterioration could be encouraged, must be answered in the negative!

1.3.2 Address of the British Agent for Rhone Poulenc

In N.L. No.13, p.8, col.2, item 181.B, I stated that R.W. Greef were the British agents for Rhone Poulenc, but the agency is now with RHODIA (UK) Ltd., Portpool Lane, London EC1N 7SH.

1.4 ATTACK ON LEADS BY ACID FROM WET OAK WOOD

There have been two cases reported recently where the inside of the leading has completely deteriorated whereas the leads on the outside of the window are still clean and undamaged. It is well known that unseasoned oak wood (or even old oak which has become damp) will release acetic acid into the air which attacks lead in the presence of CO_2 to give basic lead carbonate. The lead is usually the only material attacked, and it is destroyed completely.

The remedy is to ensure that the oak is kept dry and the building ventilated.

1.5 VISITS BETWEEN WORKSHOPS

Fraulein Juliana Rausch, from Dr Frenzel's Workshop in Nuremberg, visited British Workshops on a British Council Grant during March.

1.6 MENDING CRACKS IN GLASS

A material which has been suggested for sealing cracks in broken glass is the Minnesota 3M Research Ltd's "3M Glass Crack Sealer". It was demonstrated in the television programme "Tomorrow's World" in January 1974 and is said to seal up a crack in glass without any visible trace remaining. It is said to be available as a pack of 20 sachets at a cost of £5.00 (plus VAT) from Mr Geoffrey Wride, Minnesota 3M Research Ltd., Pinnacles, Harlow, Essex.

2 PROTECTIVE GLAZINGS

The item in N.L. No.13 has brought a number of interesting responses from readers.

2.1 EXTERNAL GLAZING AT YORK MINSTER

In N.L. No.13 (item 3.2) I gave details of the dates of installation of the external glazings of some windows at York Minster. Mr David O'Connor has kindly written to give me details of the charges made, by Joseph Robinson, plumber and glazier of York, for installing the external glazing.

(a) Five Sisters, 1861, £63
(b) West Window, 1862, £67
(c) East Window, 1862, £120.

He also points out that, on 21st October 1921, the Society for the Protection of Ancient Buildings discussed the external glazing of York Minster windows as:- "the balance of evidence is in favour of it. We would offer the suggestion, however, that it would be an advantage, especially on the south side, to leave openings in the clear borders of the internal glazing at the top and bottom of each light. (These openings should be filled with copper wire gauze to keep out insects; this gauze may be set in the lead as the glass is.) The object of this is to provide ventilation between the glasses and to minimise the effect of condensation produced by changes of temperature in an unventilated space." (RGN - it is, of course, a mistake to ventilate the cavity towards the inside of the building.) However, in May 1928 the Society changed its opinion to "no protection be put to the glass unless it is very certain that there is real risk of damage happening for want of it".

2.2 WILLIAM PECKITT'S WINDOW AT BYRAM PARK

In Fig.3 of N.L.13 I reproduced part of p.31 of William Peckitt's Commission Book, which suggested that he had purchased some strong glass for fixing behind the painted glass in the frame. I remarked that this might be one of the first instances of protective outer glazing (March 1782). Mr Trevor Brighton, who is engaged in research into Peckitt's work, has written to point out that this is the only one of the 315 entries which could be regarded as referring to protective glazing. Thus (a) Peckitt did not usually employ external glazing, (b) he often mounted glass in frames, rather like pictures, to be suspended in windows and this might be a case of strengthening the stained glass rather than providing external protection (RGN - nevertheless it would have functioned as an external protection), and (c) although Byram Hall was demolished, the window in question is still believed to be in a crate in the Orangery of the old house, and enquiries are being made about it.

2.3 COTHELE, CORNWALL

In N.L. No.13, p.6 Col.2, last paragraph, I referred to the window at Cothele where protective quarry glazing had produced a diamond-shaped corrosion pattern on the outside of the 15th Century window. Figs. 1 and 2 are reproduced, by kind permission of Mr Dennis King, from his photographs of the inside and the outside of the window. The lines of corrosion follow those of the leading of the external protective glazing. It is not known when this external glazing was installed, only that the glazing was "modified" in 1535! The space between the outer glazing and the stained glass must have been very narrow and the leads were probably touching the stained glass. Thus condensation could have collected on the inside of the outer window, along the leads, and caused this type of corrosion of the late 15c window.

Fig. 1 Cothele window from the inside, showing the dark lines of corrosion produced by the external diamond quarry glazing.

Fig. 2 Cothele window from the outside, showing how the lines of corrosion follow the leads of the external glazing, which were soldered to the diamond-quarry-leading of the medieval window. It is not known when the external glazing was put in place, but it was *removed* in 1880. Figs. 1 and 2 are by courtesy of Mr Dennis King, FSA.

2.4 ENVIRONMENT INSIDE A "PLATING"

In item 2 of N.L. No.10 (September 1974) I described a plated head from Canterbury Cathedral in which the cracks had been mended with water-soluble Lepage's glue. The glue had disappeared from the joints (presumably it had dissolved in moisture which had condensed on the inside of the window, but it is possible that it might have been digested by micro-organisms) and various kinds of "dirt" had passed through the cracks and formed quite "heavy" deposits (in one case 0.9mm thick) on the inside surface of the modern glass which had been used for plating the head on the outside.

In N.L. No.12 (item 1.5) it was stated that the black deposits were largely graphite and the white ones were gypsum. I also asked readers to send me any platings which had recently been taken from old medieval heads. The response has been marvellous and I can now add significantly to the information about the environment <u>inside</u> the plating.

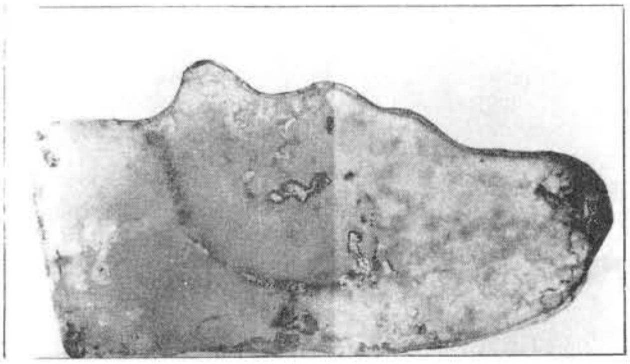

Fig. 3 The modern plating-glass as it appeared when it was taken from Resa's head. It can be seen how the dirt has passed through a crack in the medieval head, and produced a line of deposits on the inside of the glass (face No. 2, counting from the outside). There are also other deposits, both black and white in colour, on face 2, and the piece of glass has every appearance of being badly weathered.

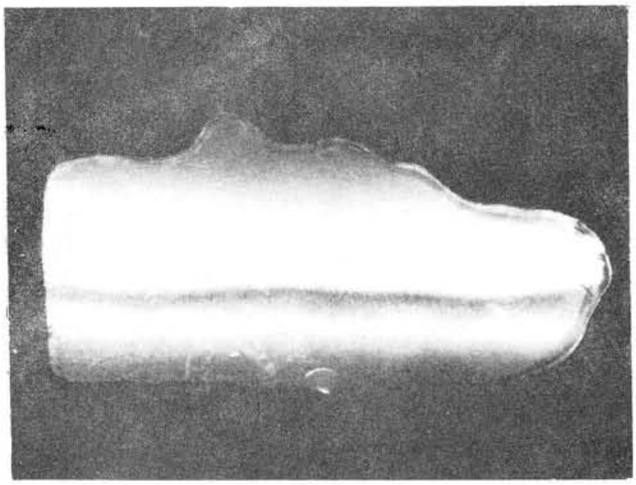

Fig. 4 The same piece of glass after being washed in cold water. The image of a fluorescent lamp is reflected in the surface and one edge of the image crosses a region where there had been heavy deposits, yet the only distortion in the image is caused by lack of flatness in the glass and not by deterioration of the surface.

Nevi Not Resa.

2.4.1 Plating from Resa's Head at Canterbury

Mr Frederick Cole has recently sent me the plating from one of the "geneaological" series at Canterbury, i.e. from Resa's head. The piece of glass measures roughly 180 x 90mm and its condition can be seen in Fig.3. The cracked head had been edge-joined with water-soluble joiner's glue, probably in 1920, but the glue had disappeared and the plating bore substantial black deposits where soot had been drawn into the space between the head and the plating as the air expanded and contracted, and also white areas. The glass certainly looked as if it could have been permanently corroded on Face No.2 (counting from the outside) but all the deposits were easily removed by washing with cold water and the 20th century glass is quite bright and shiny after some 50 to 60 years. Fig.4 shows an attempt to demonstrate the pristine surface of the glass by photographing the reflection of a fluorescent lamp in the surface. By comparison with the damage caused to the glass when a modern double-glazing unit breaks down, the environment inside this single-plated head is not one which causes harm, despite the very adverse appearance of the deposits as shown in Fig.3.

2.4.2 Plating from Waidhofen on the Ybbs

Frau Dr Eva Frodl-Kraft has kindly sent me the two cover glasses from a plated head at Spitalkirche in Waidhofen on the Ybbs. The head was cracked long ago because it can be seen to be broken in a photograph of 1882 but it was plated on both sides in 1947. The plating glasses were removed in 1974, after 27 years, and they were in excellent condition even before washing. No doubt this freedom from any kind of contamination is due to the use of two cover glasses, one on the outside and one on the inside.

The two faces which were towards the inside of the cavity (Nos. 2 and 5, counting from the outside, faces 3 and 4 being the medieval glass) seem to be quite unaffected and the side which was facing into the building (No.6) is also in excellent condition. The side which was facing the outside of the building (Face No.1) is covered with a network of fine scratches, perhaps due to wind-blown dust.

This example shows that the careful use of double-plating provides an environment for the medieval glass which is not harmful over a period of at least 27 years and no doubt much longer.

Because the only observable blemishes on Face No.1 are the multitude of fine cracks, an attempt was made to measure them with the "Talysurf", by courtesy of the Cutlery and Allied Trades Research Association in Sheffield. The instrument was set to give a vertical magnification of 10,000x and a horizontal magnification of 20x. The actual charts are difficult to reproduce and tracings were therefore made and these are shown in Fig.5.

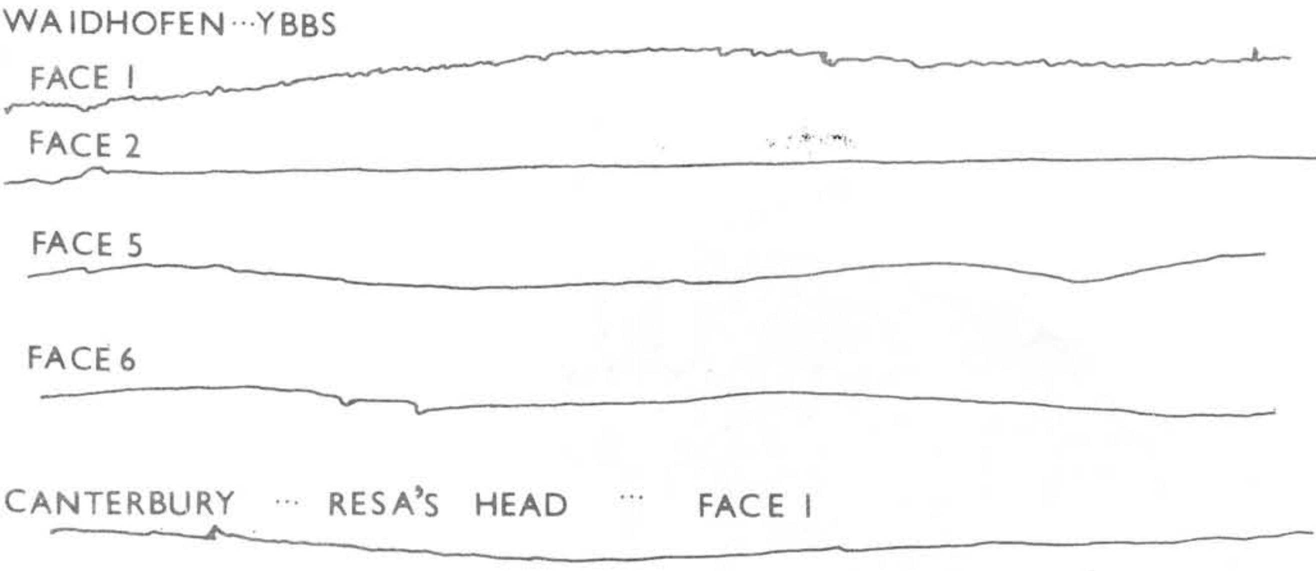

Fig. 5 "Talysurf" traces of five surfaces from glasses used for plating medieval heads. The first four are faces 1, 2, 5 and 6 (i.e., the outside and inside respectively of the outer and inner plating glasses, faces 3 and 4 being the medieval glass) from Waidhofen on the Ybbs. The fifth is from face 1 of the plating from Resa's head at Canterbury. The vertical magnification is 10,000 times and the horizontal magnification is 20 times. Face No. 1 from Waidhofen shows many more very fine scratches than do any of the other surfaces.

The top line in Fig.5 is Face 1 of the plated assembly from Waidhofen and it can be seen that there are many small notches in it, representing the fine scratches. Their sizes lie between 50 and 200 nm yet they are readily visible on the chart. By comparison, the charts for Faces 2 and 5 show only undulations and the occasional scratch which is rather larger than those on Face No.1. Face 6, towards the inside of the building, bears a few large scratches. Thus, during its 27 years in the window, the outer side of the plating developed many scratches either by the action of sand and wind, or by some cleaning of the window (perhaps even before it was installed).

The opportunity was taken of making the same measurements on the outside (Face No.1) of the plating from Resa's head and it will be seen that there is not this multitude of scratches, even though the window was in position for twice as long as the Waidhofen window! Is the Canterbury dust less scratchy? Or are the winds stronger in Waidhofen? As is usually the case in research, you try to close one door and find you have opened others which you did not suspect!

These two sets of platings (from Canterbury and from Waidhofen) have been exceedingly useful but I should still be glad to receive others from readers of the News Letters. Any which are more than 20 years old should be sent, especially if (a) they show effects not mentioned here or (b) they are more than 50 years old.

2.5 AIR FLOWS IN "PROTECTED" WINDOWS

In the Sheffield experiment, and now also at York Minster, we have been measuring air flow rates in the cavity between the glazings with the DISA low-velocity anemometer, but this costs about £600. I am grateful to Mr George Linsley for drawing my attention to the miniature smoke generators (only 120mm long) supplied by the Dräger Company because they have been very useful in showing how the air flows can be extremely complicated. For example, in one case at York Minster, where the ventilation gap was quite small (2mm wide), a narrow stream of smoke introduced at the bottom of the window travelled upwards for about 1 metre and then went downwards to come out at the bottom again, but at a different point. A set of 10 smoke generating tubes (each of which can be re-used many times) costs about £4.00 and anyone who wants to study air flows should obtain a set. In England this Air Flow Tester Kit CH 216 can be obtained from DRAEGER SAFETY LIMITED, Kitty Brewster, Blyth, Northumberland NE24 4RH, Telephone 067-06-2891. The German makers are DRÄGERWERK AG, LUBECK, Tel (0451) 8 10 21. (strömungsprüfer für Luft CH 216).

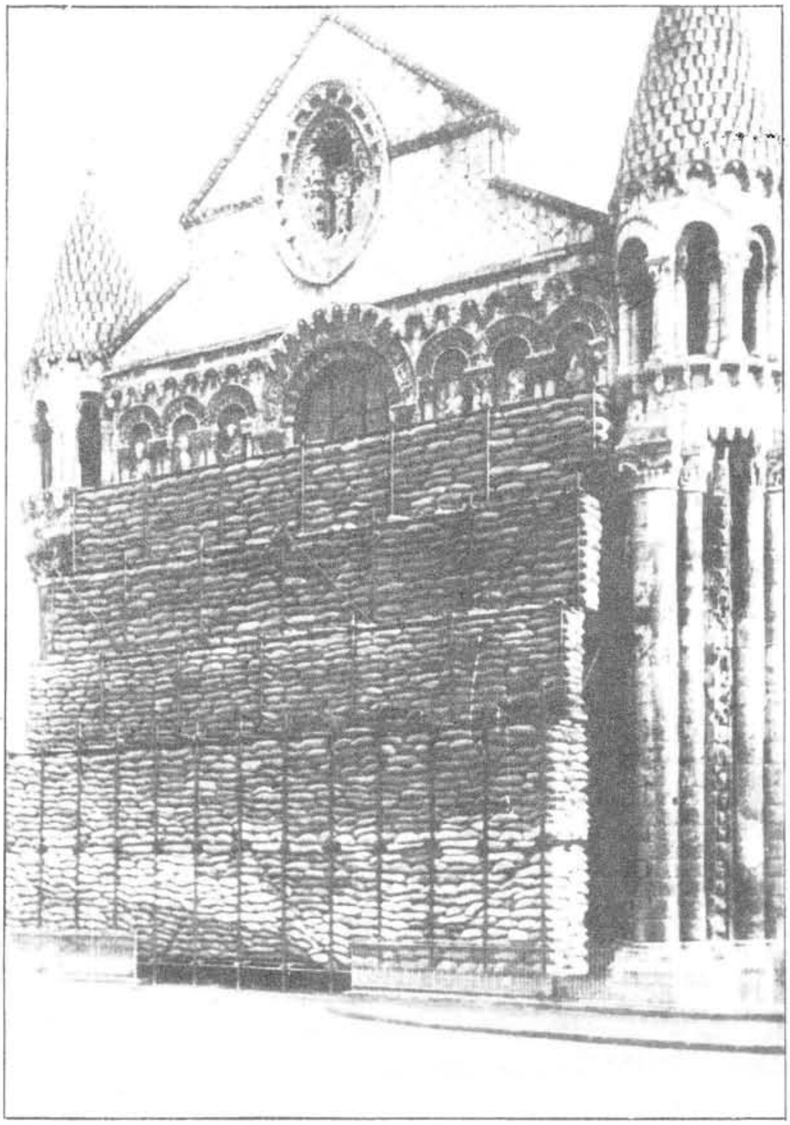

Fig. 6 The facade of the church of Notre Dame la Grande, Poitiers, as it appeared in 1940, by courtesy of Ing. J. M. Bettembourg. The wall of sandbags produced a damp environment on the facade and caused extensive damage to the stonework.

3 WAR-TIME STORAGE

3.1 GENERAL INFORMATION

Miss Judith Scott has drawn my attention to pages 20-27 of the 10th Report (1947) of the Central Council for the Care of Churches. This gives a list of windows which were removed from buildings during the war, and also those which were destroyed by bombing. In most cases there is merely a statement that the glass was removed for safe storage but in a few cases there is an indication of the place where it was stored.

For example, the important medieval glass at Thornhill, near Dewsbury (p.25), was removed in 1940 and stored underground in Ingham's Colliery. (RGN - it does not state how it was stored, but an underground colliery seems likely to be a place where the glass could get rather wet!) Some of the glass is stated to have been too fragile for removal and it had to be protected in situ (see also item 3.2 below).

On p.26 it states that the fourteenth century glass at Bere Ferrers was buried at the Rectory during the war. (RGN - Here, again, the storage situation seems potentially to have been an extremely wet one!)

In a different article in the same journal it states (p.42) that the glass of Lincoln Cathedral was buried during the war "... in an enlargement underground at the bottom of what was at one time a deep well". (RGN - yet another site likely to have been rather damp!) The glass from Lichfield Cathedral was stored in the Anglesey Vault underneath the Consistory Court and (p.43) the glass from Sheffield Cathedral was stored in a disused coal mine belonging to the Nunnery Colliery Co.

3.2 NOTRE DAME LA GRANDE, POITIERS

I am indebted to Ing. J.M. Bettembourg of the Ministère des Affaires Culturelles, in France, for information about the deterioration of the stonework in the facade of this church. It was protected in 1940 by a wall of sandbags about 60 tiers high (see Fig.6) and it is stated that the examination of a series of photographs shows that the extensive deterioration of the stonework dates from 1940, the same time as the wall of sandbags was constructed against the west facade, thereby also creating very damp conditions between the sandbags and the medieval stonework. I have therefore included Fig.6 as an example of in-situ war-time protection because it may remind someone of such protection being used for in-situ protection of windows, or even of damp sandbags being used to protect panels inside buildings, as in the crypt of Gloucester Cathedral. If it does resurrect any memories, please write to me.

4 POLISHING OF MEDIEVAL GLASS

News Letters Nos. 12 and 13 (item 2 in each case) contained accounts of a series of experiments in which various surface treatments were given to a small piece of poorly-durable green glass from York Minster, supplied by Mr Peter Gibson by permission of the Dean and Chapter. The durability of the surface, as influenced by the treatment, was measured by the extractability of potash and the results were expressed as the loss of potash per unit of weight of the glass. It has since been realised that the extraction technique removes the potash from only an extremely thin layer (only about 4 µm thick); thus the results should be expressed as the loss of potash per unit area and not per unit weight. Because the polishing techniques reduce the thickness (and hence the weight), but do not have much effect on the area, this difference in method of expression of the results could have an important effect.

The results have therefore been re-calculated in terms of the loss per unit area (actually as µg per mm^2).

The various stages of treatment have been given the same letters as in N.L. 12 and 13 and the new results are given in the table.

It now seems that the acid-polishing (g) used by Mr Cole at Canterbury, to restore brightness to the airbraded glass, improves the durability to about the same extent as does the well-known fire-polishing process (e) used in making the original glass. There are still some unexplained discrepancies because the two airbrasion treatments (c and f) have given results which differ by about 40% and it seems that the rather small samples which remained after stage (e) were relatively less durable than the original large piece. Mr Dennis King's technique of grinding and polishing (d) has given a remarkably good durability to the sample and it would be interesting to know why wet-grinding and polishing has produced such an excellent effect. I am indebted to Mr Stanley Ryder and Mr Roy Taylor, of Ramsden & Co., Stoke-on-Trent (who are experienced in wet-grinding techniques), for pointing out that there is some evidence that extraordinarily high temperatures may be developed locally by wet-grinding. For example, wet-grinding can lead to temperatures in excess of 350°C because cellulosic materials have been known to become decomposed in the process. Also, ball-milling with steel balls in a steel container can lead to temperatures in excess of 700°C because the steel has occasionally reacted with the water to produce hydrogen. It may not be so surprising, therefore, that wet-grinding and polishing of glass might lead to considerable de-alkalisation of the surface.

	Treatment	Loss of potash ($\mu g/mm^2$ in 50 h)
a	Washing	0.59
b	Effect of crust	0.63
c	Airbrasion	0.53
d	Mechanical polishing	0.25
e	Flame polishing	0.44
f	Airbrasion	0.76
g	Acid polishing	0.40

5 MORE TESTS ON VIACRYL VC 363

In item 170 of News Letter No.11 (see the second paragraph of column 2 of page 8) some French work was reported in which Soxhlet tests had suggested that 0.75 mg of alkali could be extracted from a Viacryl-coated piece of poorly durable glass in the first 80 hours, but no further alkali was extracted up to 200 hours. Moreover, it had been thought that the 0.75 mg extracted in the first 80 hours might have been caused by an alkaline impurity in the Viacryl.

These tests have now been repeated in the BGIRA laboratories in Sheffield but, unfortunately, the results are somewhat different. Four samples of glass were used, in the form of discs 16 mm diameter; all were coated with Viacryl hardened with 20% Desmodur and cured at room temperature for 48 hours. Two were of "Pyrex" glass (4.5 mm thick) which contains no potash, and two were of British simulated medieval glass No.2 (9 mm thick) in which the alkali was potash only. They were first extracted in the Soxhlet for 80 h at $85^{\circ}C$; the two Pyrex discs lost, respectively, 0.05 and 0.01 mg K_2O which suggests that very little potash exists in the Viacryl as an impurity. The two samples of glass No.2 lost, respectively, 0.60 and 0.87 mg K_2O in the first 80 h and there was a further loss of 1.13 and 1.17 mg K_2O in the next 200 h. Thus these tests suggest that Viacryl is a much better coating (for resisting the extraction of potash in the Soxhlet test) than any reported in Section 2.A.1 of News Letter No.3 (see the bottom of p.2) where the best coating had an extract of 2 mg per 100 h, compared with about 0.7 mg/100h for the Viacryl 363.

Viacryl was also applied to polished plate glass and submitted to the Pilkington Brothers' standard accelerated testing procedure (see p.5 of N.L. No.6) and Mr George Linsley reported: "After 7 cycles on test the coating showed signs of lifting and crazing which gradually increased in severity to 44 cycles, but with no apparent staining evident on the glass beneath. At 65 cycles the coating had become very badly bubbled and had lifted at the edges causing the glass beneath to become severely weathered. At this point the test was concluded." Thus, here again, the Viacryl seems to be more resistant to the test than any of the materials reported on in January 1974.

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NOTE: Will readers of these News Letters please draw my attention to any papers which should be abstracted here. It would be particularly helpful if photocopies of the papers could be supplied. My address is 5, Hardwick Crescent, Sheffield, S11 8WB, England.

Roy Newton

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