Verification of the Nature and Causes of the Photo-negative Images on the Shroud of Lirey-Chambéry-Turin

by Nicholas Peter Legh Allen

A comparison between the 1978 Shroud of Turin Research Project (STURP) data concerning the qualities of image formation on the Shroud of Turin and the inferences of the author's recent investigation into shroud-like image formation techniques employing technology readily available to medieval cultures as far back as the eleventh century strongly suggests that the negative image as found on the Shroud of Turin was the product of a form of primitive photography employing either silver nitrate or silver sulphate as a light sensitive agent.

Note

Prof. Allen's original article contained a great deal of illustrative material which could not be reproduced on Internet. But his book on this subject will be available early in 1996, published by Janus, UK.

Background

In a recently completed research project (registered with the University of Durban-Westville) which dealt with the more plausible explanations for the photo-negative images (both dorsal and frontal) of the crucified Christ on the so-called Shroud of Lirey-Chambéry-Turin, the author postulated that well before the middle of the fourteenth century people may well have possessed the necessary technical knowledge to produce a photographic negative image on an organic support such as linen or cotton.

On first appraisal the reader may well believe this conclusion to be incomprehensible. Yet, if one reconsiders the phenomenon of the Shroud in isolation, without supplication to either popular misconception, religious orthodoxy or the established dogmas of scientific opinion, that is if one considers the fact as they are presented by the Shroud as *Sache selbst*, it would seem that the only possible and logical way that the image on the Shroud could have been produced was by a photographically related technique. This conclusion only seems outlandish once it is placed within the context of our present understanding of medieval cultures and their respective levels of technology. It should be further noted that until now no hypothesis has ever been submitted for examination by both the academic and scientific community, which has been able to satisfactorily address every one of the Shroud's distinctive image characteristics as documented by the various members of the Shroud of Turin Research Project in the late 70s and early 80s.

Briefly, these characteristics of the image, as found on the so-called Shroud of Turin, may be listed as follows: 1

- *Superficiality*: Although it is quite likely that the areas associated with the stigmata are formed from blood, 2 the negative image itself is essentially the enigmatic discolouration of the uppermost fibres of the linen threads which constitute the Shroud's fabric. This image has not `penetrated' the threads in the sense that it is not visible on the underside of the Shroud. In addition, the image is not visually coherent to the naked eye at close range. 3
- *Detailed*: The Shroud's negative image, once transformed to a positive state by means of modern photography, is highly detailed, which has allowed medical experts to claim that they are able to detect the presence of such details as rigor mortis, contusion wounds, excoriations and a variety of facial wounds (Barbet 1950:23--45). It should also be considered that without the medium of modern photography it is uncertain if anyone living before c 1898 could have seen these details 4 (that is when Secondo Pia made his historic photographic negatives of the Shroud).
- *Thermally stable*: The Shroud's image was not affected by the intense heat of a fire which nearly destroyed it in 1532.
- *No pigment*: It is quite certain that no pigment was applied to the Shroud and the image is not caused by pigment, dye or stain, either.
- *Three-dimensional*: The intensity of the image varies according to the distance of the body from the cloth, strongly suggesting that the body did not in fact come into direct contact with the Shroud. The mathematical ratio is so precise that Jackson and Jumper were able to create a three-dimensional replica from the image. 5.
- *Negative*: The image is a negative which is as visually coherent as a positive photograph when its tonal polarity is reversed.
- *Directionless*: The process that formed the image operated in a non-directional fashion. It was not generated according to any directional pattern as it would have been if applied by hand. A painting, for example, shows strong directionality, that is, the direction by which the medium was applied is evident from the brush strokes.
- *Chemically stable*: The straw-yellow discolouration composing the Shroud image cannot be dissolved, bleached, or changed by standard chemical agents.
- *Water stable*: The Shroud was doused with water to extinguish the fire of 1532. Although this has caused a visible water stain, the image itself does not appear to be affected.

If one accepts that water stability and chemical stability may both be covered by the same nomenclature, then there exists a total of eight conspicuous attributes of the image which are peculiar to the Shroud of Lirey-Chambéry-Turin.

Deficient image formation theories

Broadly speaking, there are three major categories of theories which have been postulated since 1898 in futile attempts to account for the images on the Shroud. These totally unsatisfactory image formation theories may be reviewed very briefly as follows:

- ### The image was `somehow' produced by the application of paint/dye/stain/power

  Even if an artist were able to apply some staining compound that contained a proportion of red ochre, as was suggested by McCrone, 6 the fibrils would be stained throughout. One must also ask how an `artist' could possibly view what he/she were painting/staining since the image is so subtle that it can only be clearly discerned from

some distance. In short, any solution to image formation on the Shroud of Turin which insisted on the employment of pigments, dyes and staining compounds would have to explain why the artist/s concerned would have wanted to produce an image (complete with anatomically accurate details) in the negative, such that its visual information was largely inaccessible to its proposed viewing audience at the time of this manufacture.

- **The image is an imprint produced by some form of `bodily' contact**

  There are at least three main variations within this particular category of image-formation theory: The image of the man on the Shroud is

  - a natural chemical reaction between the Shroud and a real corpse
  - a man-made impression caused by covering a red-ochre stained corpse and/or three-dimensional statue with the Shroud
  - a man-made impression caused by laying the Shroud over a chemically treated corpse, or a heated, metal, three-dimensional statue. The latter method would arguably create a negative image by scorching.

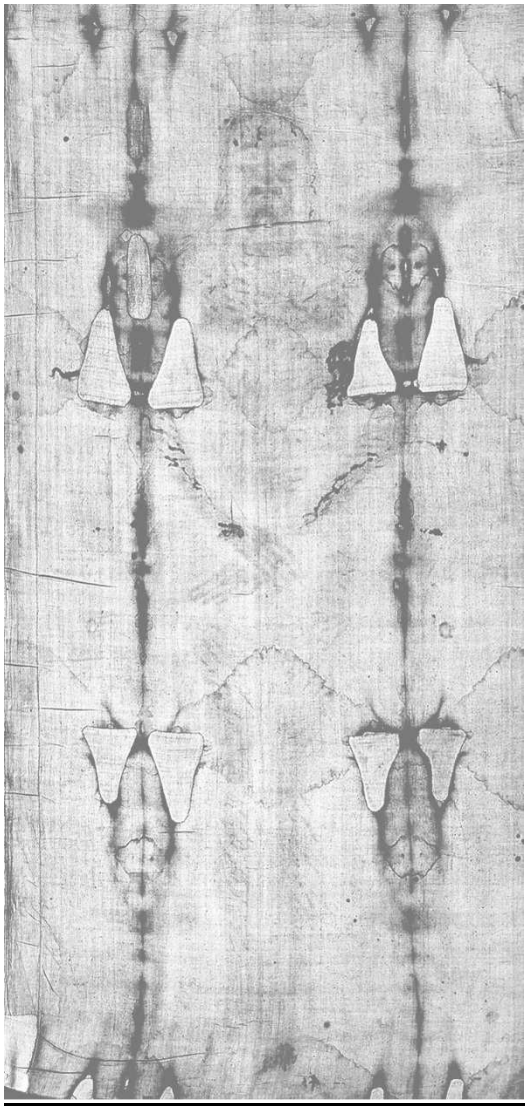
  All of the above theories may be safely excluded for one major reason viz: if the Shroud came into contact with all areas of the hypothetical corpse/body/statue that is visible in the actual image, then that image should be grossly distorted. P. Vignon (as early as 1902) undertook a series of experiments to prove this very point.

- **The image was produced naturally by chemical action (vaporography)**

  According to Vignon (1902), someone spread an unguent on the Shroud (such as myrrh and aloes) `thus rendering it sensitive to the action of organic emanations from the body'. Vignon proposed that Christ's corpse, still covered by a layer of uric acid-rich `morbid sweat' or urea (the latter produced naturally by the body as a result of a highly stressful death) was laid out naked on the Shroud and then covered by it. The urea, starting to ferment, producing carbonate of ammonia. The ammoniacal vapours rose upwards and oxidised the aloes, thus producing a negative image.

  Vignon's `vaporographic' theory (1902), has to be excluded for at least one obvious reason, viz:

  - Vaporographic images are caused by chemical changes that would be evident throughout the fibrils of the Shroud. The image on the Shroud is in fact visible only on the outer surface of the fibrils.

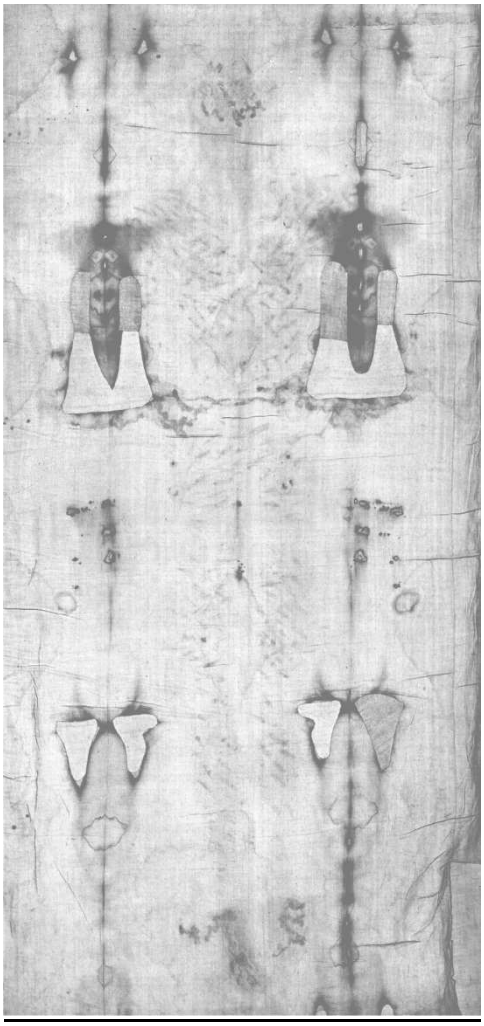


Photograph of the Shroud of Turin showing the negative frontal image of a tortured man

The need for a paradigm shift

It should be noted that most researchers have at some time or another remarked on the surprising photographic nature of the Shroud's image and it is accepted by all that in every way the Shroud acts as a negative photographic plate .7 However, no-one to date, 8 has seriously suggested that the Shroud could have been produced by photographic means. This rather obvious solution would no doubt be considered quite ludicrous because (as is well known) photography as the art of fixing stable records of the images of nature through the action of light on light-sensitive materials was discovered only in the early nineteenth century!

Yet, if one reviews the findings of the 1973 and 1978 STURP commissions, both of which carefully analysed the characteristics of this seemingly paradoxical image, one can only conclude that some form of radiated energy (heat or light) could have formed the image, and arguably the simplest way to produce an image by a form of radiated energy is by employing some form of photographic-related technology.

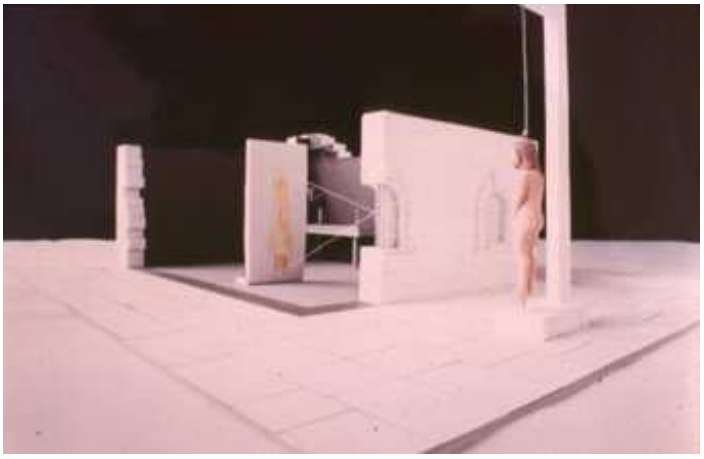


Photograph of the Shroud of Turin showing the negative dorsal image of a tortured man

Since 1990 the author has formally conducted a number of experiments which have employed the kind of technology available to certain medieval societies c 1200--1350 AD, and has shown that it is quite possible to produce a chemically stable (fixed) negative photographic image of a human corpse on a piece of linen employing only three substances, all of which were available to people living well before the thirteenth century. These substances are quartz (rock-crystal), the silver salts (specifically silver nitrate (*eau prime* and silver) and/or silver sulphate (oil of vitriol and silver) and ammonia (urine) (Allen 1993a:23--32; 1993b; 1994:62--94).

More specifically, if a piece of linen, permeated with a dilute solution of either silver nitrate or silver sulphate, is positioned inside a camera obscura , it can record (in the negative) the details of a sun-illuminated subject situated outside the camera obscura. It must be stressed that this image can only be obtained if it is focused onto the linen cloth by means of a quartz (optical quality, rock-crystal) bi-convex lens. In addition, for this image to be life-sized (for example the dimensions of an adult human corpse), it is necessary for the combined image conjugate and object conjugate distances to total about 8,8 metres. In other words, the subject to be `photographed' must be positioned (that is outside the camera obscura) some 4,4 metres from the aperture, whilst the screen supporting the prepared linen cloth must correspondingly

be placed at a similar distance from the aperture (inside the camera obscura). At these long distances it is essential that the lens should have as large a diameter as possible (for example, well over 60 mm 9;) so that as much light as possible enters the camera obscura. It is important to emphasise here, that a pinhole and/or lens made from optical quality glass will not suffice for this purpose. Indeed, only optical quality quartz will permit the passage of UV radiation from the subject (corpse) to the specific silver salt which impregnates the linen material, and both silver nitrate and silver sulphate are particularly sensitive to the UV end of the light spectrum (particularly 195 to 240 nm). The image thus obtained is in the negative, and (surprising as it may seem) after immersion in ammonia becomes chemically stable. In fact, by immersing the cloth in urine or dilute ammonia it is possible to remove all traces of silver (reduced or otherwise), and the cloth together with its encoded negative image may be brought out of the camera obscura into the light of day. The image is only visually coherent at a distance of some two to three metres, appears only on the upper fibrils of the cloth and is a record of the illumination of the subject over a period of days. For this latter reason the visual record contains a negative encoding of the three-dimensional characteristics of the original subject. In this context at least, the image is unlike a modern photographic negative in that it is not a `snap-shot'of a particular moment in time, 10 but rather the record of the original subject according to the physical distance of a particular feature of the subject from the prepared organic support (for example linen cloth). If a photographic negative is made from this cloth, then a highly detailed, positive image of the original subject will result. Readers should compare this image with the positive image of the head from the Shroud of Lirey-Chambéry-Turin.



Hypothetical model, illustrating how the Shroud of Turin was manufactured c 1260-1320 AD

The photographic hypothesis

From the preceding evidence alone it is possible to postulate that somebody in the late thirteenth or early fourteenth century may have had the necessary knowledge and materials to have taken either a human corpse or even a life-like bodycast and have suspended it vertically in direct sunlight for an unspecified number of days such that it (the corpse) received an equal amount of morning and afternoon illumination. This subject (corpse or bodycast) would have had to have been situated opposite an aperture (containing a simple bi-convex quartz lens) of a light-proof room (camera obscura). Inside this room or camera, it would have been necessary for a large screen to support the linen cloth (Shroud), which had been previously treated with a very dilute solution of either silver nitrate (0,5%) or silver sulphate (0,57%).

The inverted image of the corpse would have been focused onto this prepared support and after a few days the UV sensitive silver salt would have turned purplish-brown, forming as it did a negative photographic image of the subject. To achieve the twofold image which now appears on the Shroud of Turin, it would have been necessary for this operation to have been repeated twice to obtain an impression of both the frontal and dorsal images of the sun-illuminated corpse. After both exposures had been completed the linen cloth would have been soaked briefly in a dilute solution of ammonia (5%) or possibly even urine. This latter action would have ostensibly removed all silver (both exposed and unexposed) from the linen cloth and also would have allowed it to be exhibited outside the camera even in direct sunlight, without further discolouration occurring. Even though the silver salt had been removed, the cloth would have still contained a faint negative straw-yellow image -- one which seemed to be encoded in the very structure of the linen itself, albeit on the upper fibrils.

Photograph of the life-size body cast of a human subject (1993-94) based on the image as found in the Shroud of Turin

Practical experiments with silver nitrate and linen

The photo-negative images which served to illustrate the hypothetical account stated above were produced during a series of practical experiments conducted between 1990 and 1994 (Allen 1993b).

If re-photographed (by more conventional means), these negative images on linen may be viewed in the positive, in which they reveal a wealth of detail not normally available to the human eye. This phenomenon quite clearly conforms very closely to the characteristics of the

image as found in the Shroud of Turin and if this hypothetical account is in any way accurate, it strongly implies that the Shroud of Turin may be the only extant example of a lost photographic technology which is normally assumed to have been first discovered in the early nineteenth century by such people as Thomas Wedgwood and Sir Humphry Davy. However, it would seem to stand to reason that a final proof for the validity of the photographic hypothesis (as briefly reviewed above) would have to wait until the Shroud of Turin was yet again subjected to a series of suitable scientific tests (albeit non-destructive). Fortunately, however, the Shroud of Turin Research Project (STURP) tests, which were conducted on the Shroud in 1978, have furnished enough appropriate information to allow for a productive comparison of both the characteristics of image formation as found on the Shroud and the characteristics of image formation as found on the various test samples produced by the author between 1990 and 1994. It is therefore possible at least to propose a scientifically verifiable model -- one which explains the nature and the specific cause of the photo-negative image as found on both the Shroud of Turin and the 1992 linen test piece. To this end the more pertinent results of the 1978 STURP commission are reassessed briefly below.

Infrared reflectance spectroscopy and the Shroud of Turin

As a result of a series of infrared reflectance spectroscopy investigations made by J S Accetta and J S Baumgart in 1978 it was possible to compare the spectral features of selected Shroud features (that is areas of `bloodstain', body image, `pristine' linen and scorch and water marks caused by an accidental fire in 1532). In particular, it was found that no notable differences existed between the spectral features of the scorch marks and those areas of the linen which contained details of image. Accetta (1980:1924--5) states that the image areas are

> those parts of the cloth containing the anatomical attributes of the figure in the cloth. Generally, spectra were taken in those areas where the image was visually dense ... Spectral comparisons of linen and a moderate scorch ... display similar features in the 3-5- and 8-14-mm bands ... In general, scorch spectra are invariant with respect to visual intensity, showing nearly identical absolute reflectances in both spectral bands. Furthermore, there exists almost negligible spectral variation between scorches and bare linen ... laboratory observations of scorches on linen are similar to scorches on the Shroud. Also shown is a marked similarity between image and scorch areas in both spectral bands.

Accetta (1980:1925) goes on to conclude that the

> spectral similarity of the image areas to known scorches is noted and is consistent with observation in terms of color in the visible region of the spectrum, however; this result is not without ambiguity since spectral similarities are characteristic of most areas examined as shown by the data in both spectral bands.

Photomicrography and the Shroud of Turin

Another member of the STURP team, S Pellicori, produced a series of photomicrographs of the Shroud in 1978. He noted that although there was a notable difference between the scorch marks and the water marks of 1532, he did observe certain similarities between the scorch marks and areas of image. Pellicori (1981:34--43) informs us that the water stains

had some distinct characteristics, notably that they penetrated the linen's threads to all depths, including around bends and into crevices in the fibre, which made for a darkish brown saturated appearance. The water stains also have an abrupt boundary where the unwetted areas begin. The scorches on the other hand, altered the coloring of the bulk of each fibril to a constant density -- that is, also regardless of bends and crevices. But as might be expected from a scorch, these marks had a diffuse and gradual boundary.

Pellicori (1981:41) also tells us that the body image itself is

a uniform, light sepia yellow color on the points of highest relief of the threads, or in other words, on the surface of the Shroud. There is no indication of any artificial coating or pigments on the surface of these darkened fibrils. Some areas, presumably those where contact between the body and Shroud was more complete or direct, simply have more of the darkened fibrils. The images of the cheek, eyes and fingers are primarily registered on the upper crowns of the threads. Yet even in the darkest and atypical of areas -- the heel and nose -- the image stain does not penetrate to the reverse side of the cloth and shows no evidence of any mixture of blood.

Visual comparisons between the image characteristics of the Shroud of Turin and the author's 1992 test image

The various STURP reports concur with the visual observations made of the test sample produced in 1992 with silver nitrate as well as the more recently produced test (1994) known as the Shroud of Port Elizabeth, the latter being produced with silver sulphate. To this end, a visual comparison of the image as found on the Shroud of Lirey-Chambéry-Turin and on these test pieces reveals that all three images on cloth have the following common characteristics:

- a straw-yellow discolouration of the upper fibrils of the linen material (Pellicori 1981:34--43; Wilson, 1978:9)
- the appearance of being photographic negatives which are only visually coherent at distances upwards of two metres (Wilson 1978:9; Ostler 1988:56)
- no pigment, powder, dye or stain (Stevenson 1981)
- no directionality
- thermal stability
- water stability
- relative chemical stability in that the author's test pieces are affected by household bleach to the same degree as any other mild scorch on organic material is altered.

The image as seen in plate 7 was produced by the actions of UV radiation (195--240 nm) (Allen 1993b) on a linen cloth sample (300 x 200 mm) saturated in a dilute solution of silver nitrate (0,5%). This image (which took at least four days to form) was originally a dark purplish-brown colour . After immersion in a dilute solution of ammonia (5%), this image appeared to lose much of its detail and simultaneously assumed its present straw-yellow colour. However, when rephotographed, the negative print reveals a highly detailed, positive image of the original subject (2).

Towards formulating a plausible theoretical model for image formation on the Shroud of Turin

From this visible result, the following hypothesis may be conjectured:

- the purplish-brown image is caused by reduced silver nitrate in the presence of UV radiation;
- after immersion in an ammonia solution, most of the silver is removed from the linen cloth, and
- the resultant straw-yellow image is formed not by the presence of silver but by a structural (chemical) alteration to the linen (cellulose) itself.

To test this hypothesis a number of tests were conducted.

Verification of the photographic hypothesis

To confirm the exact concentration of any possible residual silver nitrate, an ICP-MS analysis of the digested cloth was undertaken by E H Evans. For this purpose six samples of linen material were prepared as previously described. The analyses were performed in triplicate on both blank and treated samples:

- Three samples, each measuring 300 x 200 mm, and labelled A^1, A^2 and A^3 respectively, were saturated in a solution of silver nitrate (1%). These were exposed to the sun until they had turned a uniform dark purplish-brown and were dry to the touch. These samples were each immersed in a solution of dilute ammonia (5%), cursorily washed, dried naturally in sunlight and sealed in sterile plastic envelopes. . Three samples, each measuring 300 x 200mm, and labelled B^1, B^2 and B^3 respectively, were left untreated and sealed in a sterile plastic envelope.

Evans determined the exact levels of silver contained in these samples by employing the following method:

Sub-samples (0,5 g) were cut from each of the six linen samples, and heated gently with concentrated nitric acid (10 ml) for approximately two hours (that is until nitrogen oxide fumes ceased to be given off). The sub-samples were then boiled down to approximately 2 ml and then quantitively transferred to 25 ml volumetric flasks and made up to volume with deionised distilled water. 250 µl of indium solution (10 µ l^{-1}) was added as an internal standard. Analysis was performed using Inductively Coupled Plasma Mass Spectrometry. Evans noted that the digestion had not been completely successful, as some undigested material (possible colloidal in nature) settled out at the bottom of each flask. Although it is quite certain that most of the analyte remained in solution, given the high acid concentration, Evans advises that the following test results should only be regarded as semi-quantitative:

Figure 6

ICP-MS test results

Sample ID	**Ag concentration (mg g^{-1})**	**ppm**
B^1(untreated)	<0,0002	,2
B^2(untreated)	<0,0002	,2

B[3] (untreated)	<0,0002	,2
A[1] (treated)	0,4	400
A[2] (treated)	0,2	200
A[3] (treated)	0,2	200

6 Inductively coupled plasma mass spectrometry test results

Considering that the treated samples analysed by Evans had higher concentrations of silver nitrate than was employed in all of the test pieces which contained an image and in addition were not washed as vigorously as pieces containing an image, it is certain that the residue of silver (in any of the test samples containing an image) will be far lower than the figures reflected above. It should also be borne in mind that the concentrations of silver in a piece of linen saturated with silver nitrate (1%) (before being washed with ammonia) would be about 10 000 ppm. This result very strongly indicates that the permanent image as found on the test piece is formed solely by a chemically induced alteration to the linen fibres (cellulose) and not by silver.

Viscosity and methylene blue tests on the 1992 test pieces In the light of the preceding data, it was necessary to deduce what changes were occurring to the linen material which could account for the straw-yellow discolouration of the upper fibrils. To this end, P F Schürek undertook a series of standard tests to determine if there was a change in the degree of polymerisation of the cellulose and hemicellulose in the treated linen samples when compared to untreated linen samples. These were conducted by Schürek in accordance with the procedures laid down by the British Standard Method test for the determination of the cuprammonium fluidity of cotton and certain cellulosic man-made fibres.[11]

The following results were obtained:

- The degree of polymerisation (DP) was reduced from an average of 2 800 (for untreated linen) to an average of 2 100 (for treated linen).

In addition, a standard methylene blue test was conducted in accordance with the procedure as described by Earland and Raven (1971). This test, which is dependent on the absorption rate of methylene blue by cellulose, indicated that the cellulose of the treated linen samples was more oxidised than that of untreated linen samples.

Discussion

In the light of the work undertaken by the STURP commission in 1978 and from the data reviewed briefly in this paper, it is possible to propose a hypothetical model for both the nature and the causes of the structural alteration which occurs to the cellulose of organic fibres such as linen, cotton and hemp when they are saturated in silver nitrate solution, exposed to UV radiation and immersed in dilute ammonia, viz:
The silver salt (for example silver nitrate) is reduced by the actions of the UV range of the

light spectrum. This reduction may be expressed chemically as and is thus responsible for the production of free radicals. These are produced by the action of the UV radiation on the nitrate ions that compose the compound. These in turn cleave the molecular chains which

form the cellulose structures of the linen fibrils. These cleavages (oxidation) are possible in certain places along the cellulose polymers (that is both branched and linear structures). Briefly these may be identified as follows:

- oxidation between the ketone groups at C^2 and C^3; and/or
- oxidation of the primary alcohol group at C 6 to the aldehyde group; and/or
- oxidation of the primary alcohol group at C 6 to the carboxyl group; and/or
- esterification of the acetal groups at $C^1$to the carboxyl groups and subsequent cleavage of the cellulose chain.

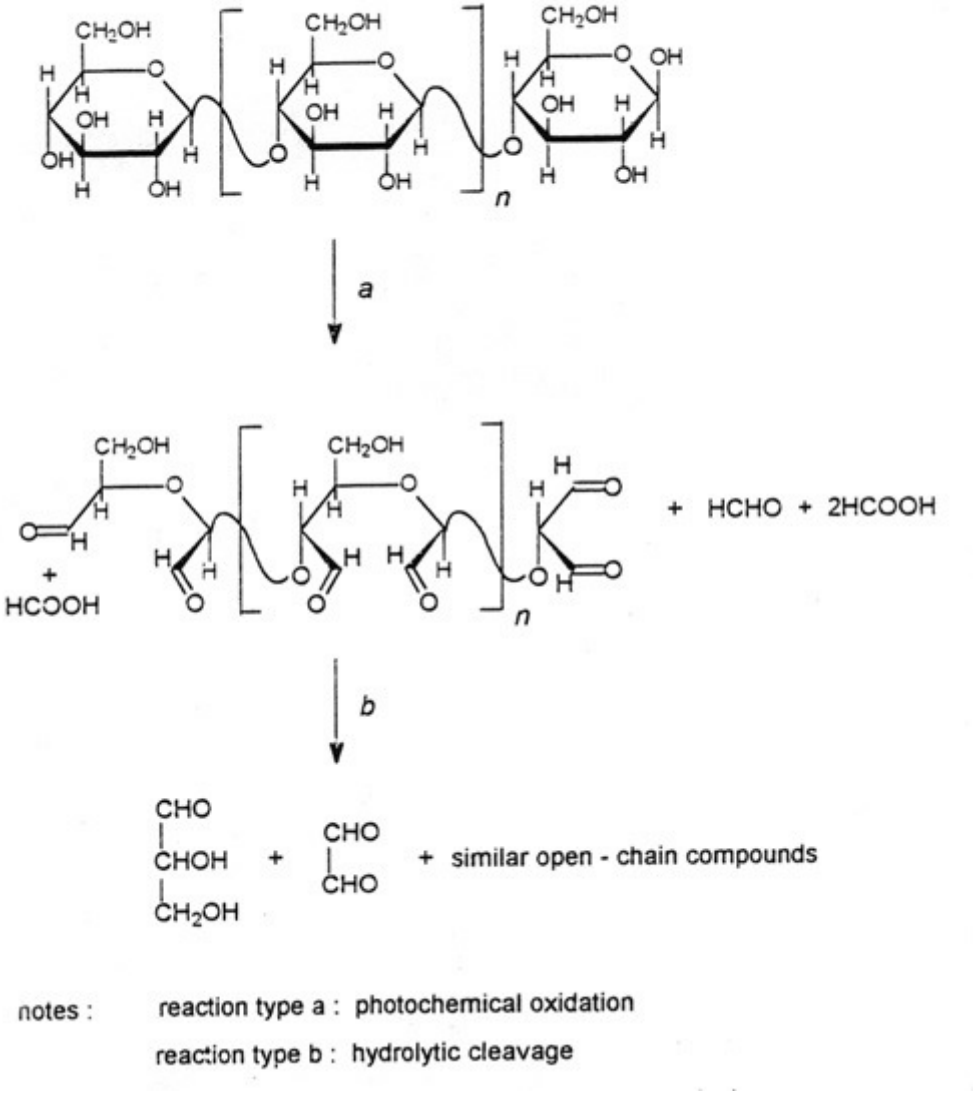


Figure 7

A proposed model which explains but one possible occurrence of photochemical

degradation of a typical carbohydrate polymer (such as may be found in an organic fibre such as linen).

This chemically induced oxidation of the cellulose, which is structurally similar to oxidation caused by natural ageing and scorching, is proportionally more prevalent on the uppermost fibrils which constitute the linen threads and is presumed to be more intense in low crystallinity zones. It is also important to note that in addition to the possible cleavages caused directly by the action of the free radicals (as stated above), the possibility equally exists that these free radicals could give rise to an energy transfer. Briefly stated, as a result of the action of UV radiation the generated free radicals could cleave the hydrogen bond of the hydroxyl group of cellulose. This in turn could liberate a hydrogen ion which could also be responsible for yet further cleavages in any of the following cellulose groups, viz:

- the carboxyl group
- the ketone group
- the adelhyde group.

It is quite certain that it is not possible to achieve the very specific qualities of image as found on the Shroud of Turin and the 1990--1994 test samples by any artistic or natural process which involves the use of vapours, dyes, pigments, powders or stains. It is known that the Shroud was most likely manufactured sometime after the mid-thirteenth century (Anderson 1988:25) (definitely not later than 1357 AD and is not miraculous. Indeed, the fact that the Shroud is not a miraculous product should not be viewed as a threat to anyone's religious convictions so long as that faith is not solely dependent on a piece of medieval fabric. It would seem therefore (subject to further corroborative testing of the Shroud itself) that the hypothetical photographic technique, as elucidated earlier in this article, is the only plausible explanation for image formation on the Shroud of Lirey-Chambéry-Turin and indicates that people in the late thirteenth or early fourteenth century were indeed privy to a photographic technology which was previously thought to be unknown before the beginning of the nineteenth century.

The implications that this has for the history of technology and the history of art cannot be underestimated and far from condemning the Shroud of Turin as a mere medieval forgery or clever `fake', we should strive to ensure that this remarkable and unique vestige of a lost medieval technology be carefully preserved for future analysis.

NOTES

1 This list of image formation characteristics is based on the information supplied by Stevenson and Habermas (1981).
2 Pellicori (1980:1916) noted that `the absorption spectrum of a blood particle removed from the Shroud independently suggests that blood is present. Furthermore, the resemblance to blood as seen in the photomicrography of these areas is strong. The spectrum suggests denatured met-haemoglobin.'
3 Wilson (1978:9), states that `[t]he colour of the imprint can best be described as a pure sepia monochrome, and the closer one tries to examine it, the more it melts away like mist'.
4 It is possible for a person to see the positive image on the Shroud of Turin by staring at its negative image for a short period of time and then observing the after-image which forms on the retina. The author has experimented with this technique with the Shroud of Turin's image

and his own shroud-images.

5 Jackson and Jumper produced three-dimensional models of the man in the Shroud by enhancing the photographs taken of the Shroud in 1931 by G. Enrie. For this exercise, they made use of a VP-8 Image Analyzer.

6 McCrone claimed to have detected the presence of red ochre (which is ostensibly iron oxide and a binder) in the Shroud's fibres. At first appraisal this would seem to support the notion that some painting medium was employed in the production of the Shroud's image. However, if one considers that the microchemical tests (as carried out by A. Adler) detected no pigments or even binders for pigments of any kind to a level of less than a millionth of a gram, then surely we are left in no doubt that even if present, red ochre has nothing to do with the image itself (cf. Stevenson 1981:135--8).

7 Ostler's comments are typical of this myopic condition, viz: `the shroud remains as mysterious as ever, reason: it bears an inexplicable life-size image of a crucified body, which is uncannily accurate and looks just like a photographic negative -- occurring centuries before photography was invented' (1988:56).

8 One exception to this state of affairs came to light only quite recently. Indeed, in August 1994 two Britons, L Picknett and C Prince published a book entitled *Turin Shroud: in whose image? The shocking truth unveiled*. Although published a few months after the author's own independent findings, Picknett and Prince claim that since 1988 they have also been exploring the possibility that the Shroud of Turin had been produced by photographic means. However, although at first appraisal this claim would seem to be supportive of the author's own conclusions, it should be appreciated that these two researchers' adhere to the somewhat sensationalist notion that the Shroud of Turin is a self-portrait produced by none other than Leonardo da Vinci in 1492. This is some 135 years after the Shroud was first exhibited at Lirey in c 1357!

9 The author originally employed a 40 mm lens for the 1992 test pieces as these only involved small-scale subject matter such as the plaster head (2). However, for full length figures the best results have been obtained with a 180 mm quartz bi-convex lens which has a focal length of 2,2 metres. The large diameter of this piece of apparatus has made it possible for the author to stop down the aperture at will, in an endeavour to calculate the smallest diameter possible for this particular image forming technique.

10 It is interesting to note that Kunz and Räther (1995:120--1) humorously referred to the author's findings as `evidence' for `Schnappschuß aus dem Mittelalter'. This notion is extremely misleading as it fails to take cognisance of the fact that the Shroud would have required several days of exposure to a sun-illuminated subject. In this sense the Shroud is not so much a `photograph' as a `solarograph' and is in effect quite similar to a suntan.

11 Cf BS2610:1978.

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