The viability and possible applications of high resolution mark replicator casting compound in document examination

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Mark replicator casting compounds are commonly associated with recovering toolmark detail. A series of experiments was designed to identify the possible applications, and assess the overall viability, of using mark replicator compound to record indentations on questioned documents. The trials included testing the effect of Isomark™ High Resolution Mark Replicator on different paper-based substrate types, and observing in particular, any damage that it may cause. The experiments also tested the effect that the mark replicator has on subsequent fingerprinting techniques. It was found that the mark replicator successfully recorded indentations on paper and card surfaces. In some cases, the mark replicator caused staining on some of the surfaces and had a negative effect on the quality of fingerprints subsequently developed.

Des composés de moulage pour copier des marques sont communément associés aux détails des traces d'outils. Des expériences ont été menées pour déterminer des applications possibles pour ces produits et leur fiabilité pour enregistrer les foulages sur les documents. Les essais comprenaient des tests de l'effet du Isomark™ High Resolution Mark Replicator sur différents types de substrat en papier et, en particulier, déterminer tout dommage qu'il pourrait causer. Les expériences ont également permis d'observer les effets du matériel de moulage sur les techniques de détection des traces digitales subséquentes. Le produit de moulage a permis d'enregistrer avec succès les foulages sur papier et carton. Dans certains cas, le produit de moulage a provoqué des taches sur certaines surfaces et a eu un effet négatif sur la qualité des traces digitales révélées ensuite.

Abformmaterialien werden üblicherweise mit der Sicherung feiner Werkzeugspuren in Verbindung gebracht. In einer Reihe von Experimenten wurde untersucht, ob diese Materialien auch zur Abbildung von Eindruckspuren auf Dokumenten eingesetzt werden können. Darüber hinaus sollte die Durchführbarkeit der Methode eingeschätzt werden. Die Versuche beinhalteten Tests zu den Auswirkungen von Isomark™ High Resolution Mark Replicator auf verschiedene Papier-basierende Substrattypen; besonderes Augenmerk lag dabei auf den möglicherweise hierdurch verursachten Schäden. Mit den Experimenten wurden auch die Auswirkungen des Abformungsmaterials auf eine nachfolgende Sichtbarmachung von Fingerabdruckspuren überprüft. Es wurde festgestellt, dass mit dem Abformungsmaterial Eindrücke auf Papier- und Kartonoberflächen erfolgreich abgebildet werden können. In einigen Fällen verursachte das Material Verschmutzungen (Anfärbungen) auf verschiedenen untersuchten Oberflächen und beeinträchtigte die Qualität der nachfolgend sichtbar gemachten Fingerabdrücke.

Los compuestos moldeados con el replicador de marcas son comúnmente asociados con la obtención de huellas de detalles de instrumentos. Se diseñaron una serie de experimentos para identificar y valorar la viabilidad de la posible aplicación del replicador de marcas de compuestos al registro de hendiduras o muescas en documentos dubitados. Los ensayos incluyeron el análisis del efecto del replicador de marcas de alta resolución Isomark (tm) en diferentes sustratos de papel y observar en particular cualquier daño que pudiera producir. Los experimentos también analizaron el efecto que el replicador de marcas tenía en las subsiguientes técnicas de huellas dactilares. Se encontró que el replicador de marcas registraba con éxito las muescas sobre superficies de papel y cartulina. En algunos casos, el replicador de marcas producía una tinción en alguna de las superficies y tenía un efecto negativo en las huellas dactilares que se desarrollaban a continuación.

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Introduction

In some instances it is difficult to visualise, let alone capture, indentations on some questioned documents. Perhaps the type of substrate is not suitable for treatment by ESDA and the surface bearing the indentations has a visually "noisy" printed design that makes it difficult to visualise the indentations using other conventional means such as oblique light. Examples of such substrates include the covers on hardcover books that have glossy colourful designs.

To overcome such problems casting techniques may be a viable option. Previously reported methods of this type have included using metal spray equipment [1] and silicone rubber [2].

Isomark High Resolution Mark Replicator (Isomark™) is a fast curing silicone casting material that was introduced as a product capable of replicating minute indentational detail from primarily mechanical machinery. It is a two stage polymeric compound that, upon mixing, forms a plastic-like substance that can mould into any indentations down to the accuracy of 0.1 microns (depending on the product used). It has been proposed that this substance can be applied in the field of document examination where other methods of visualising indentations, such as ESDA, cannot be employed. Each type of replicator has optimal operating conditions and specified working and curing times. Document examination is generally conducted at room temperature and products best suited to this environment are available, namely the grey T2 product, which was used for these experiments.

Wherever possible a document examiner uses non-destructive techniques when examining questioned documents. It has also always been preferred that, where appropriate, documents should be sent to the document examiner before undergoing fingerprint treatment. This is because certain methods used to develop latent fingerprints render some current indentation examinations ineffective. The question therefore arises as to whether using Isomark™ casting material will have a negative effect on the outcome of subsequent fingerprint examinations and cause damage or staining to the questioned document.

The aim of this series of trials was to determine the overall viability of Isomark™ in applications related to document examination, with a primary focus on commonly encountered substrate materials. Several tests were incorporated into the investigation. These were firstly the testing of Isomark™ on different substrate materials, including: glossy notebook cover; envelopes of different paper quality; standard 80gsm office paper; glossy coated paper; recycled paper/newsprint; heavy and light coated and uncoated cardboard. Secondly, testing the impact of Isomark™ on subsequent fingerprinting techniques. Lastly, retesting the document after fingerprinting, in order to ascertain if certain methods of fingerprint development render indentation replication by this method impossible, as is the case with the ESDA technique.

Additional experiments were developed as a consequence of investigative needs and experimental findings.

Methods and materials

Indentations on all substrate materials were made by one writer using their natural writing pressure and a black Bic ballpoint pen to write the word 'indentations' on a piece of 80 gsm lined office paper. This paper rested on top of the substrate, which had a cushion of ten sheets of lined office paper beneath. Indentations were produced that were of similar sizes and pressures throughout in order for a proper comparison of results to be achieved.

Isomark™ T–2 Grey High Resolution Mark Replicator compound was used in these trials. It was applied using the supplied applicator gun and mixing nozzle that was designed to ensure an automatic air-free mix. The manufacturer's specifications describe the compound as having a working life of five minutes and a curing time of 20 minutes at 25°C although a curing time of approximately ten minutes was found to be sufficient. Once the compound was placed on the substrate a backing sheet was placed over the top and gentle pressure applied to smooth out the compound beneath. The manufacturer supplied backing sheets, but backing sheets from ESDA adhesive film were also found to work well. Once cured, the Isomark™ adhered to the backing sheet and could be lifted free from the indented substrate. The application of Isomark™ to all indented documents in experiments one and two occurred in the same session in order to utilise only one mixing nozzle.

Substrates Used

Substrate A – Glossy coated paper/newsletter

Substrate B – Standard office paper (80 gsm)

Substrate C – Heavier office paper (120 gsm)

Substrate D – Lined office paper (80 gsm)

Substrate E – Glossy covered notebook

Substrate F – Glossy card (telephone book cover)

Substrate G – Light glossy card (tea bag box)

Substrate H – Thick, heavyweight corrugated card

Substrate I – Recycled paper/newsprint (pages of telephone book)

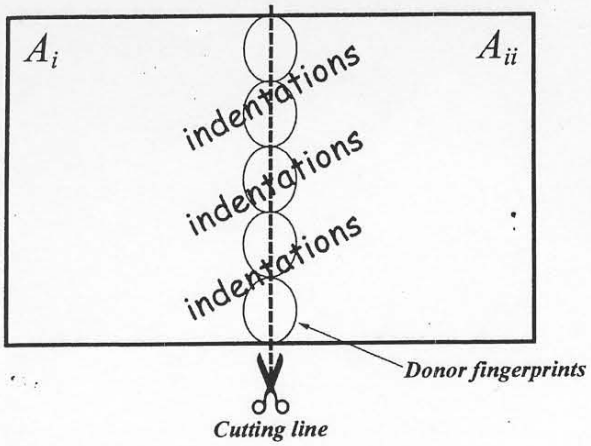
Substrate J – Standard white envelope

Substrate K – Brown manila envelope

Experiment One: testing of different substrates

Experiment One involved forming indentations on a small area of all of the substrate materials. Then Isomark™ was applied to the indented area, and a backing sheet was placed over the replicator compound, and using gentle pressure it was spread beneath the backing sheet. The Isomark™ was allowed to cure (approximately ten minutes). After curing, the backing sheet holding the Isomark™ was removed and the resultant impressions in the Isomark™ observed by enlarging and mirroring them using the VSC 2000 and oblique light. Damage, if any, made to the original documents was observed and recorded.

Figure 1 Experiment 2. Indentations were made on small area of substrate materials. Fingerprints were applied to the indented area of substrates and area was divided into two halves, A_i and A_{ii}.



Experiment Two: effects of Isomark™ on subsequent fingerprint examinations

Experiment Two involved forming indentations on a small area of all of the substrate materials. Fingerprints were applied to the indented area of substrates A, B, F, H, I, J and K. Each fingerprint/indented area was divided into two halves (Figure 1).

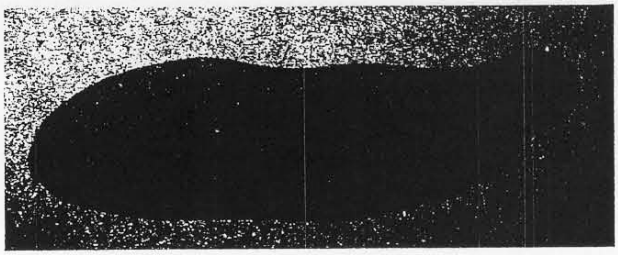
One half (i.e. A_i) was treated with Isomark™ compound to record the indentations. Both halves were subjected to the appropriate fingerprinting process for that particular substrate. In a high percentage of cases involving fingerprint development on documents in New Zealand, Ninhydrin is routinely used, especially when dealing with standard porous paper types. With glossy or coated paper it is often necessary to use cyanoacrylate (super glue) fuming techniques to visualise the prints.

Any visible differences were recorded between A_i and A_{ii} after fingerprinting using appropriate methods.

Experiment Three; retesting after fingerprinting

Experiment Three involved re-using substrates from Experiment Two to determine if it was still possible to record indentations after fingerprinting. Both halves of the substrates were retested with Isomark™. The results were compared with the original Isomark™ impressions obtained from Experiment Two. All findings were recorded.

Figure 2 Isomark™ Staining. The result of using Isomark™ on a porous surface. In this case Substrate K, the brown manila envelope. A similar result was observed on all porous substrates.



Results and discussion

Experiment One

This experiment was successful from the point of view of the future use of Isomark™ in document examination. It showed positive results in capturing indentations from a number of substrate materials, particularly glossy and coated papers and cards.

Any non-calendered/non-glossy paper or card was damaged or stained by the Isomark™ (Figure 2). Despite this obvious damage a very good record of the indentations was still achieved from nearly all substrates.

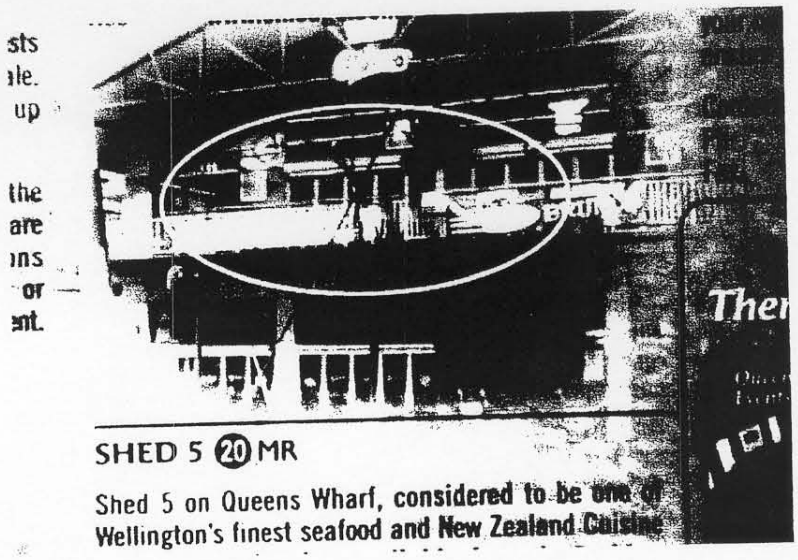
Where a visually "noisy" surface is on a substrate that is not suitable for ESDA treatment, it is often difficult to visualise indentations using sidelight. An example of the indentations successfully recorded using Isomark™ on a colourful newsletter, Substrate A, is shown in Figure 3.

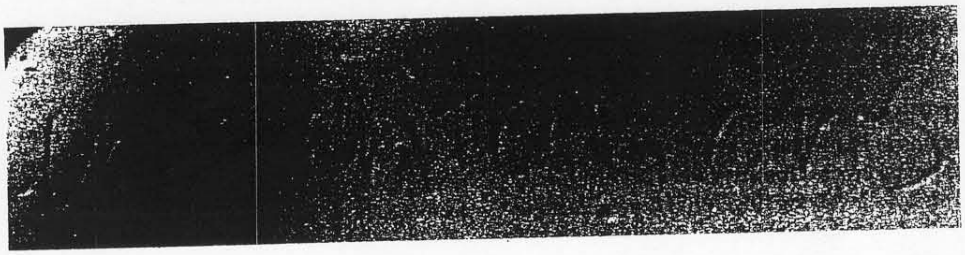
The nature of Substrate H, the heavy corrugated card, did not lend itself well to receiving indentations. However, some indentations, albeit illegible, were still recorded using Isomark™.

Table 1 Experiment 1: The results of Isomark™ treatment to capture indentations on different substrates.

Substrates Tested	Description	Legible indentations achieved?	Comments/Damage?
A	Glossy paper/newsletter	Yes	No visible damage?
B	80 gsm office paper	Yes	Bad staining of document
C	120 gsm office paper	Yes	Bad staining
D	80 gsm	Yes	Bad staining
E	Glossy cover of notebook	Yes	No visible damage
F	Glossy card	Yes	No visible damage
G	Light glossy card	Yes	No visible damage
H	Thick, corrugated card	No	Moderate level of staining, poor indentations

Figure 3 Above: Image of Substrate A, a glossy newsletter. The white oval marks the position of the indentations. Below: The indentations lifted from Substrate A.





Substrate I, the low quality telephone book newsprint paper, is highly unsuitable for Isomark™ application. The printed detail on the surface of the paper was transferred to the Isomark™, which meant that it was impossible to see if any legible indentations had been recorded.

Experiment Two
This part of the trials yielded some interesting results relating to the effects of Isomark™ on subsequent fingerprint treatment.

Substrates B, H, I, J and K were treated with Ninhydrin, and Substrates A and F were subjected to cyanoacrylate fuming to develop the prints. For Substrate F, recording of the resultant differences between the two halves of the original document was achieved via illumination with IR light. Comparing the two halves, Figure 4 clearly shows that the use of Isomark™ had a negative effect on the quality of fingerprints. Definite degradation has occurred in the overall resolution and the ridge detail of the fingerprints developed on the side where Isomark™ has been applied.

Given this degradation, the lift removed from Substrate F was treated using cyanoacrylate fuming and the application of Panacryl (Basic Yellow 40) to enhance the cyanoacrylate prints. This established that some of the fingerprint residue had adhered to the Isomark™ compound.

Due to the highly patterned nature of Substrate A (newsletter) it was necessary to use coaxial lighting in order to visualise the difference between the two halves. It could clearly be seen that, as with Substrate F, the use of Isomark™ caused degradation in the quality of the print developed.

The Ninhydrin developed prints revealed a rather different result. It was observed that Isomark™ had little or no effect on the subsequent fingerprinting techniques. A likely reason for this lies in the substrates. Ninhydrin is traditionally used on porous substrates such as uncoated paper as was the case in these trials. These porous substrates allow the water-borne amino acid of the fingerprint to be absorbed into the paper. In contrast the glossy/coated substrates for which Cyanoacrylate was used, do not permit absorption to occur, leaving the fingerprint on the surface and open to damage/lifting by the Isomark™ treatment.

Experiment Three
Re-application of Isomark™ after fingerprinting revealed some

Table 2 Experiment 2: The Effects of Isomark™ on Subsequent Fingerprint Examinations.

Substrates Tested	Description	Fingerprint Treatment Used	Degradation in fingerprint development due to Isomark™?	Comments?
A	Glossy paper – newsletter	Cyanoacrylate	Yes	Definite degradation observed
B	80gsm office paper	Ninhydrin	No	No apparent degradation
F	Glossy card	Cyanoacrylate	Yes	Definite degradation observed
H	Thick, corrugated card	Ninhydrin	No	No apparent degradation
I	Low quality paper, telephone book pages	Ninhydrin	No	No apparent degradation
J	White envelope	Ninhydrin	No	No apparent degradation
K	Brown manila envelope	Ninhydrin	No	No apparent degradation

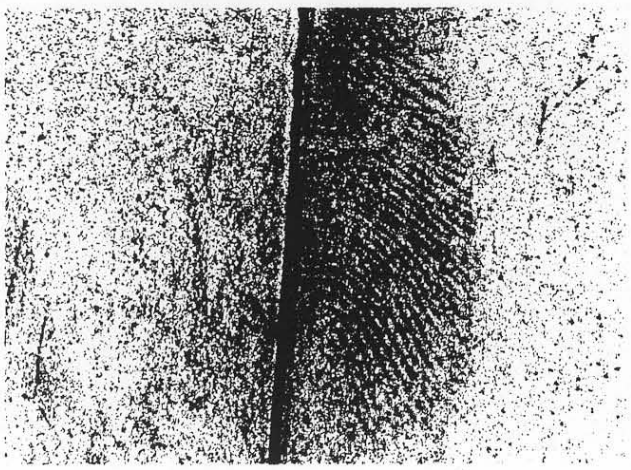
varied results. The fairly poor quality of original indentations of the substrates used in Experiment Two slightly hindered this investigation. The documents that were subjected to cyanoacrylate fuming do not appear to have been affected and indentations developed after fingerprinting were as clear as before. For the other documents, which were treated with Ninhydrin, there appeared to be a very slight degradation in the quality and sharpness of indentations developed.

Additional Experiments

Reapplication of Isomark™ to documents

Isomark™ was reapplied to several of the original documents from Experiment One in the same position as before. The resultant impressions were compared to see if any deterioration of impressions occurs if Isomark™ is applied to a document more than once. In all cases, there appeared to be no noticeable difference between the quality of indentations recorded from the primary and secondary applications of Isomark™.

Figure 4 Substrate F, Glossy Card. Isomark™ was applied to the left half of the document. This has resulted in significant degradation to the left portion of the fingerprint when subsequently developed using cyanoacrylate fuming, as is seen in this negative image.



Application of Isomark™ to pre-typed carbon typewriter ribbons

During microscopic examination of the Isomark™ impressions it was possible to see that along with the indentations Isomark™ had also recorded the minute details of the paper fibres of the original indented document. The future application of using Isomark™ in matching paper fibre patterns could prove to be very useful in document examination. Further investigation was carried out to establish if Isomark™ was capable of reproducing paper fibre detail from carbon film typewriter ribbons. This experiment involved the application of Isomark™ to sections of pre-typed carbon ribbon, on the carbon side. Some sections of the ribbon were treated with the carbon intact, others were tested with the carbon removed. Results were viewed microscopically to determine if fibre detail from the paper that was typed upon had been reproduced successfully. Results show that Isomark™ was very successful in the replication of minute paper fibre detail on the typewriter ribbons.

Conclusions

The future of Isomark™ replicating compound in document examination may be limited to specialised cases or circumstances. It does achieve good results in recording indentations in paper and card in nearly all cases. This is particularly useful in cases where the substrate prevents the use of ESDA and the glossy and visually "noisy" printed design on the substrate makes it difficult to visualise the indentations using conventional means such as oblique light.

Using Isomark™, indentations on documents can still be visualised after the documents have been treated using both ninhydrin and cyanoacrylate fingerprint development techniques. This is significant as occasionally documents are sent for fingerprint treatment prior to document examination and therefore some current techniques to develop indentations, such as the use of ESDA, cannot be applied.

However, the results also show that the use of Isomark™ can have a negative impact. On a glossy substrate, Isomark™ reduces the quality of subsequent fingerprints developed. It has been found that Isomark™ adheres to and therefore removes some fingerprint residue on glossy surfaces. Further, if used to visualise indentations on porous paper surfaces, Isomark™

causes significant damage and staining. Where neither fingerprinting nor damage is an issue then Isomark™ may be applied in a wider range of cases.

As a direct result of these trials, it has been found that the replication of paper fibres by Isomark™ has practical value in matching typed questioned documents back to the carbon ribbon from which they were produced. Although not seen in these trials, potentially this high level of resolution achieved in replicating paper fibres could in itself, in some instances, cause "noise' on the subsequent Isomark™ lift, thereby hindering the interpretation of any indentations.

Since the trials were undertaken that are the subject of this paper, Isomark™ High Resolution Mark Replicator has proved successful in casework in capturing handwritten indentations on two substrates where ESDA could not be used and where oblique lighting proved ineffective. These substrates were the colourful glossy cover on a hardcover diary and the top of a wooden bar stool involved in a kidnapping case.

From these trials and the successful capture and interpretation of indentations in casework where ESDA could not be used and where side lighting proved ineffective, it is clear Isomark™ has a place within document examination. However, individual consideration must be made with respect to its use in each case due to the negative effects Isomark™ may have on fingerprints and on particular substrates.

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