

TECHNICAL NOTE

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An Ideal Material for the Preparation of Known Toolmark Test Impressions

ABSTRACT: Traditionally, toolmark test exemplars are produced by applying a tool's working surface to a piece of soft metal such as lead. Soft, pliable metals are primarily used for this purpose because they will replicate the microscopic grooves present on a tool's working surface without damaging the tool. In this paper the authors present an alternative material for the preparation of test toolmarks. Jewelry modeling or carving waxes are utilized in this study. These waxes are designed for the jewelry modeling industry to create very fine, highly detailed wax models of jewelry pieces that will be cast in various metals utilizing the lost wax casting method. Jeweler's waxes have been found to be ideal for preparing test toolmarks from exemplar tools. The test tool's working surface is applied to a piece of the appropriate wax in a manner consistent with the tool's design. The replicas obtained are exact, highly detailed, 1:1, negative impressions of the exemplar tools working surface, have a long shelf-life, and are suitable for use in toolmark examination and comparison cases.

KEYWORDS: forensic sciences, known toolmark exemplars, jewelry modeling wax

The importance of preparing accurate, negative test toolmarks for use in toolmark comparisons has long been recognized (1–7). Typically, questioned toolmarks collected from scenes of crime are negative impressions of the tools which made them. In toolmark comparison cases it is understood that it is always better to compare the actual questioned toolmarks from the crime scene with known test toolmarks than a cast or even a photograph (8). Therefore, it is always preferable to use known test toolmarks made in the same way as the original questioned toolmarks.

Classically, test toolmarks are made on sheets, bars or tubes of soft metal or metal alloys such as lead, woods alloy, and more recently lead tape. These materials are utilized for many reasons. To begin with, they are soft enough to make test prints with the exemplar tools without damaging the tool's working surface. Next, their malleable nature facilitates the reproduction of the fine nicks and grooves present on the tool's working surface, in the form of striation marks. Finally, the resulting known test toolmarks are precise, highly detailed, 1:1 negative impressions of the tool's working surface. However, the reproduction of several identical appearing test toolmarks is often quite difficult to achieve with soft metal test materials. In addition, the use of such heavy metals has been curtailed because of the health hazards they pose to the examiner.

Yet, other materials such as single and double component silicone casting materials have been used with some success at crime scenes for preserving and recording questioned toolmarks present on objects that are not practical to remove from the crime scene. Although

these substances are useful as forensic casting materials, they produce positive impressions of questioned toolmarks. It is always preferable to examine and compare the actual negative questioned toolmarks from the crime scene with negative test toolmarks made with the suspected tool.

For these reasons the authors have sought after alternative materials to produce known standard test impressions. The materials described in this paper yield, precise, highly detailed, non-shrinking, resilient, long lasting, 1:1 negative test impressions of suspected tools.

Methods & Materials

The materials chosen by the authors to prepare known toolmark standards are a series of colored, non-toxic, carving waxes adopted from the jewelry design industry. These waxes have been found to be ideal for preparing questioned test toolmark exemplars for many reasons. The carving waxes enable the toolmark examiner to easily reproduce exact replicas of a tool's working surface. The resulting replications reveal in fine detail the class characteristics, wear patterns, damage, accidental markings as well as the minute microscopic striation patterns present on the tool's surface.

The known toolmarks are prepared in the same manner as established in a typical toolmark protocol. The working surface of the tool is applied to the surface of an appropriate shaped piece of a suitable carving wax. Next, precise, 1:1, negative test toolmarks are produced with the exemplar tool in a manner similar to the way it is theorized that the questioned toolmarks were fashioned. The standard toolmarks are then examined and compared directly to the questioned toolmarks by visual means, stereoscopically and on a reflected light comparison microscope. Figure 1 depicts a series of test toolmarks made with a single screwdriver held at various angles to the surface of a disk of hard carving wax made by FerrisTM. The only aspect that varied in producing these marks was the depth of the marks. Figure 2 depicts four of the test toolmarks chosen

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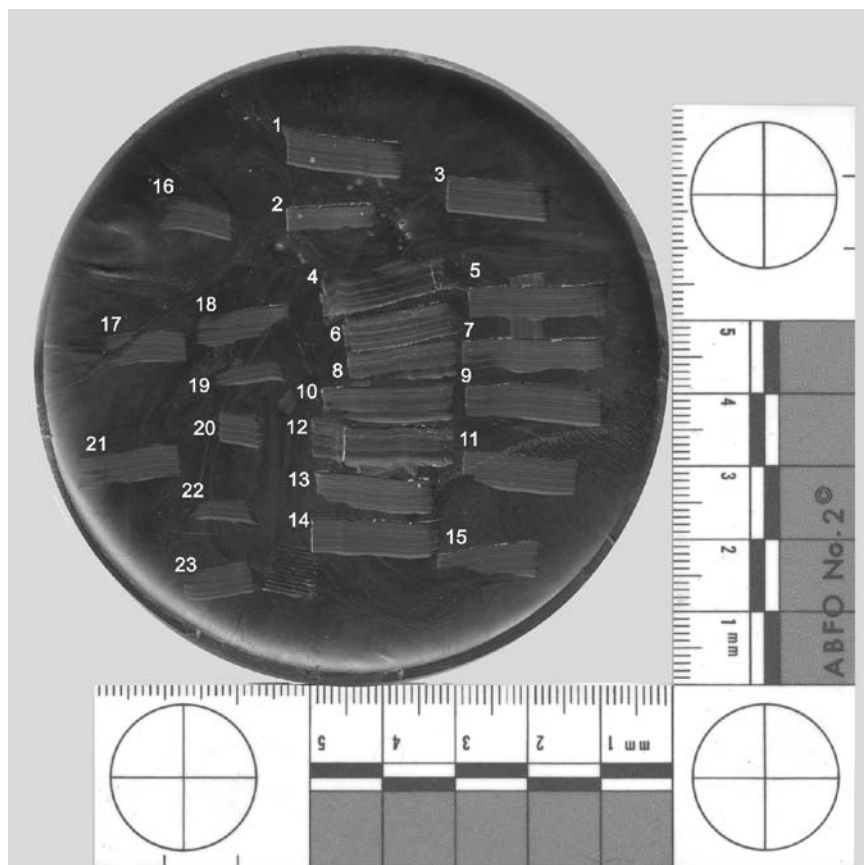


FIG. 1—A series of twenty-three (23) test toolmarks made with one screwdriver. All twenty-three exemplar toolmarks were prepared in less than 1 minute.

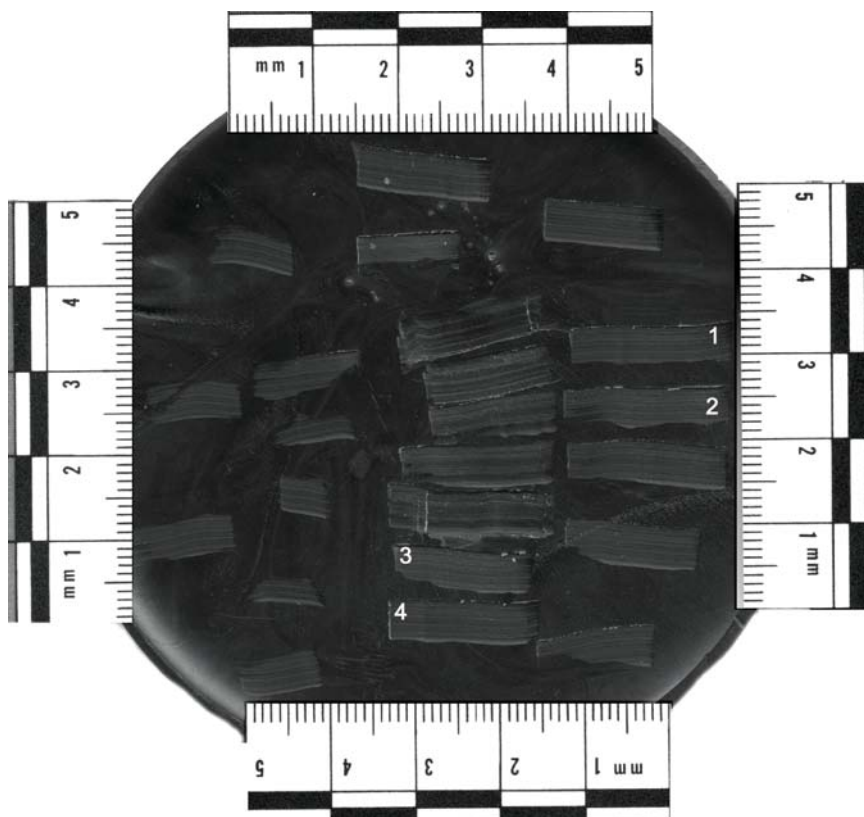


FIG. 2—Four random exemplar toolmark were chosen from the twenty-three test toolmarks.

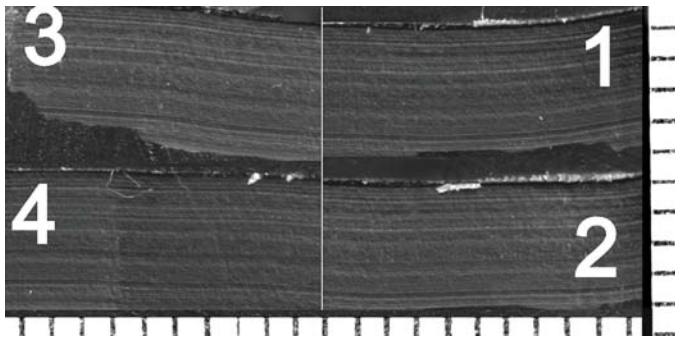


FIG. 3—Four randomly chosen test toolmarks depicting the same striation marks made by the test tool (screwdriver).

at random for enlargement as seen in Fig. 3. Examination of the striation marks present in each of the test toolmarks in Fig. 3 reveals that they all have the same minute striation pattern.

Discussion

The primary purpose of a toolmark examination and comparison is to determine if a particular tool made a questioned mark or series of marks. In a typical case, a careful examination of the questioned toolmark(s) is conducted. This assessment usually reveals information concerning the class and size of the tool used to make the questioned marks, whether the tool is damaged, and the way in which the tool was employed to produce the suspected marks. Next, precise, 1:1, negative test marks are produced with the study tool in a manner similar to the way it is theorized that

the questioned toolmarks were fashioned. The test toolmarks are formed by applying the working area of the tool’s surface to a piece of modeling material. It is important to note that prior to making the test toolmarks a thorough examination of the exemplar tool(s) for trace evidence is conducted. Any potential trace evidence is to be collected and safeguarded for future analysis.

Jeweler’s carving waxes possess many positive features, which make them ideal for the production of known exemplar toolmarks. To begin with, they are designed to render highly detailed, intricate carvings that can be cast into jewelry. Next, they are non-shrinking, and have the ability to acquire and maintain fine minute details. They are easily worked with hand tools as well as power tools, and are available in a variety of formulations to meet various carving needs. Some are flexible and can bend into angles up to 90° without breaking, others are semi-flexible and can be folded, while others are hard, brittle and rigid, and can be easily cut into clean, crisp intricate shapes.

Additionally, these modeling waxes come in a large variety of sizes, shapes, gauges, and thicknesses, are free of air bubbles, and have melting points that enable them to be stored at normal room temperatures without deleterious change. If the desired shape of wax is not available, the examiner can easily melt and pour the wax into a vessel with the required form without changing the wax’s properties. When packaged properly they travel easily without breaking, and have a long stable shelf-life.

Finally, these waxes are readily available and reasonably priced. Table 1 contains a list of some carving wax manufacturers, the waxes properties, trade names, some of the common shapes that are available and the classes of tools with which to attain the best results. Figure 4 depicts an assortment of the available shapes.

TABLE 1—A selection of modeling waxes ideal for use for making test toolmarks.

Trade Marks	Color	Hardness	Mp*	Sheets**	Wires**	Blocks**	Tubes**	Best Results—Tool
Matt™	Blue	Soft	93.3	Yes	Yes	Yes	Yes	Wire & bolt cutters, knives, scissors, hammers, pliers
	Purple	Medium	104.4	Yes	Yes	Yes	Yes	Hammers, axes, hatchets, knives, pipe wrenches, wrenches, pliers, scissors, prying tools
	Green	Hard	110.0	Yes	Yes	Yes	Yes	Saws, drills, chisels, screwdrivers, prying tools, pipe wrenches
Kerr™	Purple	Very Soft	73.0			Yes		Hammers, axes, hatchets
Ferris™	Blue	Soft	116.0	Yes	Yes	Yes	Yes	Wire & bolt cutters, knives, scissors, hammers, pliers
	Purple	Medium	116.0	Yes	Yes	Yes	Yes	Hammers, axes, hatchets, knives, pipe wrenches, wrenches, pliers, scissors, prying tools
	Green	Hard	116.0	Yes	Yes	Yes	Yes	Saws, drills, chisels, screwdrivers, prying tools, pipe wrenches

* Mp – Melting Point in degrees centigrade (°C); ** Available Shape.



FIG. 4—An assortment of some of the various shapes and sizes in which the carving wax is available.

Conclusion

This paper presents an alternative material for preparing test toolmarks from exemplar tools. We believe that this technique provides the forensic community with a new and superior material for the reproductions of the working surfaces of tools. The replicas obtained are accurate, precise, highly detailed, 1:1 negative copies of the exemplar tools. They reveal in fine detail the class characteristics, wear patterns, damage, and accidental markings present on the tool's surface.

The material presented shows great promise for use in forensic toolmark cases that involve the examination and comparison of toolmark evidence. The material is safe to work with, easy to use and requires no significant change in the typical protocol for preparing test toolmarks from suspected tools. This material presented a safe, alternative substance for the reproduction of toolmarks. It is not meant to replace the well-established materials now in use, but rather to provide a new complementary material available to the forensic science community.

References

1. Hatcher JS, Jury FJ, Weller J. Firearms investigation, identification and evidence. Harrisburg, PA: The Stackpole Company, 1957;438–41.
2. Söderman H, O'Connell, JJ. Modern criminal investigation. 5th ed. New York: Funk and Wagnalls, 1962;169–75.
3. Davis J. Toolmarks, firearms and the striagraph. Springfield, IL: Charles C. Thomas, 1958.
4. O'Hara CE. Fundamentals of criminal investigation. 3rd ed., 3rd printing. Springfield, IL: Charles C. Thomas, 1974;705–11.
5. Kirk PL. Crime investigation. 2nd ed., In: Thornton, JI, editor, New York: John Wiley & Sons, 1974;360–78.
6. Svensson A, Wendell O, Fisher BA. Techniques of crime scene investigation. 3rd ed., New York: Elsevier, 1981;212–23.
7. Moenssens AA, Inbau FE, Starrs JE. Scientific evidence in criminal cases. 3rd ed., Mineola, New York: The Foundation Press, 1986;236–40.
8. De Forest PR, Gaensslen RE, Lee HC. *Forensic science an introduction to criminalistics*. New York: McGraw-Hill, 1983;383–88.