

# Bullet Castings: Recovery of Striations

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## Abstract

The objective of this research was to determine the best casting material and method to cast fired bullets. In the forensic firearms field, the comparison of fired bullets using a comparison microscope is the most useful way to match a fired bullet to a particular firearm. Fired bullets can be traced back to the gun from which they were fired by careful examination and comparison of the tiny scratches on their surfaces known as striations. These striations are used to compare a recovered bullet from a scene to a bullet fired from a suspected weapon at the crime laboratory. Images of bullet striations can be entered into the National Integrated Ballistic Information Network (NIBIN) and searched against known and unsolved firearms cases in the database. Instead of sending the questioned bullet from one jurisdiction to another for comparison, castings can be made. This allows one jurisdiction to keep the original evidence and maintain chain of custody, while still providing assistance to another jurisdiction. Further, multiple castings can be made so multiple jurisdictions can conduct their own analyses simultaneously.

The first casts were made with Mikrosil® and TRITECHFORENSICS Silicone Casting Material. The casts produced were negative images of the bullets. This means that the striations on the cast were backwards and orientated the opposite way of the bullet's striations. Although the casts were negative images of the bullet, they still produced quality images of the fired bullet. Since they are negative images of the bullet it is not possible to compare the casts with the bullet; only cast-to-cast comparisons can be done. To combat this, a double cast was made by pouring Rio Grande® jeweler's wax into the first casts to make a wax bullet.

The striations on each land and groove of the fired bullet were counted. The striations on each land and groove of the wax bullet produced were counted. The obtained average percent recovery was 85% for the lands and 82% for the grooves.

## Introduction

Firearms evidence examination is a subset of tool mark evidence examination. Tool marks are formed on evidence when a hard material is forced against a softer material, leaving striations in the softer material (1). Striations are the microscopic contour variations on the surface of the bullet (1). In firearms evidence, the softer material is the bullet and the harder material is the gun barrel. Firearm examiners use the striations left on the fired bullet for their comparisons. If a gun is recovered in an investigation, a test round is fired from the gun. These bullets are then examined using a comparison microscope. The firearms examiner's best tool is the comparison microscope, which is used to examine two different objects, bullets in this case, simultaneously. This lets the examiner compare the striations left on the fired bullets (2).

Firearms are rifled during their manufacturing process, with the exception of smooth bore guns, such as shotguns. The rifling of the gun's barrel stabilizes the bullet and gives a more accurate aim to the projectile. The rifling also gives firearms examiners the tools needed to match a suspected firearm to a fired bullet from a crime. Each gun barrel has class, sub-class, and individualizing characteristics left behind during the manufacturing process (3) (5). Examiners have been able to correctly distinguish between bullets fired from consecutively rifled gun barrels (4) (6) (7). This is important; if the firearms examiners were able to distinguish between consecutively made gun barrels manufactured with the same rifling bore, it shows that even consecutively made firearms will leave different striations. This allows bullets to be individualized to the gun from which they were fired. This suggests that no

two gun barrels leave the same striations. Over time, with wear and debris inside the barrel, the number of individualizing characteristics increases.

Sometimes castings need to be made of the fired bullets. This need can arise when there are problems with jurisdiction. Examiners may need to gain access to a fired bullet that is in a different area. In order to maintain chain of custody, a casting of the fired bullet can be sent in lieu of the actual fired bullet (8) (9). Another reason to make castings is if an NIBIN hit is made and the bullet needs to be physically examined with a comparison microscope, but the bullet is in a different jurisdiction; a cast can be made and sent to the laboratory for comparison (9). By inputting a bullet into the NIBIN system, the examiner is hoping for a list of potential matches. These potential matches determined by the software are not all matches to the bullet entered. Each bullet listed in NIBIN has to be microscopically compared by a firearms examiner before a match can be confirmed (12).

One objective of this research is to determine which method gives the best cast to use for comparison. There are several methods to making casts of fired bullets (10). In this research, double casts were made with jeweler's wax. According to Interpol, a plastic or resin could be used to make a double cast that would be resilient to change or alteration (9).

Another problem for firearms examiners is that many bullets submitted for comparison come in fragments. These fragments have to be examined microscopically to determine if there are any parts of the fragment that have enough markings to be used in a comparison (11).

## Materials and Methods

Fired bullets were placed under a Leeds Firearm Comparison Microscope. Each land and groove of the bullet was photographed using SPOT Advance version 4.6 software. The first casting material used was Mikrosil®. Mikrosil® is a silicone-based casting putty that comes in two separate tubes. White, brown, and gray Mikrosil® were used; the brown was found to have the best color for viewing striations under the microscope. Equal lengths of each tube were squeezed onto a card and mixed together for a few seconds. The Mikrosil® was then spread onto the fired bullet's surface. This method caused many air bubbles in the cast. Next, the Mikrosil® was mixed and placed in a bottle cap. The fired bullet was then placed in the cap and rotated to cover all sides of the bullet. This method also left behind many air bubbles in the cast. A small piece of solid wood was then drilled with holes 1/2 inch, 13/32 inch, and 23/64 inch in diameter. The Mikrosil® was then mixed and spread into the opening of the 13/32 inch hole and the bullet was forced in the hole to allow the Mikrosil® to cover its entirety. This hole was used for 9mm bullets and the 1/2 inch hole was used for .40 and .45 caliber bullets. The holes for each caliber were large enough to avoid scratching and damaging the striations on the surface of the bullets as they were guided into the holes. The Mikrosil® was not easily removed from the wood bar. A small steel bar was then drilled with the same diameter openings using a drill press to create smooth holes. The Mikrosil® was easily removed from the steel bar, but under the microscope air bubbles were still present. According to the information from the company, Mikrosil® takes longer to dry in colder temperatures. The steel bar was placed in the freezer to cool to hopefully slow the rate of drying. The Mikrosil® was mixed and placed in the opening of the cold steel bar. The bullet was then guided to the center of the hole using a toothpick and forced into the hole. The bar was returned to the freezer for approximately 20 minutes while the Mikrosil® set. The bar was then removed from the freezer; the bullet and cast were removed from the bar. The cast was then inverted to show the side with striations and photographed under the microscope.

The second casting material used was the TRITECHFORENSICS Silicone Casting Material. Four parts silicone rubber, one part catalyst and 2 drops of accelerant were mixed together. This mixture was then placed in the opening of the metal bar. The fired bullet was guided into the opening and allowed to set for 30-45 minutes. The bullet and cast were then removed from the bar. The cast was photographed under the microscope. These casts were bright blue and striations were not distinct under microscope.

Double casts were then made using Rio Grande® jeweler's wax. The wax was melted in an oven. When the wax melted, the molten wax was placed in the Mikrosil® or TRITECHFORENSICS cast still in the metal bar. The bar was placed in the oven to allow wax to settle. Wax was added until the entire cast was filled.

The wax and bar were allowed to cool. The wax bullet was then removed from bar and photographed under the microscope. The striations on each land and groove of the fired bullets were counted as well as the striations visible on the wax bullets.

## Results

Figure 1, below, shows the fired bullet in one of the holes of the metal bar used to make the casts. The Mikrosil® and TRITECHFORENSICS Silicone Casting Material casts gave a negative image of the fired bullet. These casts, being a negative image of the bullet, had the striations in the opposite orientation from the actual fired bullet. Figure 2 shows the land of a fired .40 caliber bullet. Figure 3 is a photo of the Mikrosil® cast of the same land of the same .40 caliber bullet from Figure 2. The striations on the land in Figure 3 are a negative image of the striations in Figure 2. To make a cast in the same orientation as the fired bullet, jeweler's wax was used to make a double cast. The double cast wax bullet is shown below in Figure 5 with the corresponding bullet in Figure 4. The double cast, jeweler's wax bullet (Figure 5) is in the same configuration as the fired bullet in Figure 4. Figure 6 shows the correlation between the same land of a wax bullet and a fired bullet. The land shown in Figure 6 is the same land of the bullet shown in Figures 4 and 5. In Table 1 the number of striations counted on each land and groove of a fired 9 mm bullet and its corresponding wax bullet are shown with the percent recovery of striations. Due to time constraints, only one bullet was counted for the recovery of striations.



Figure 1. Metal bar with bullet in hole

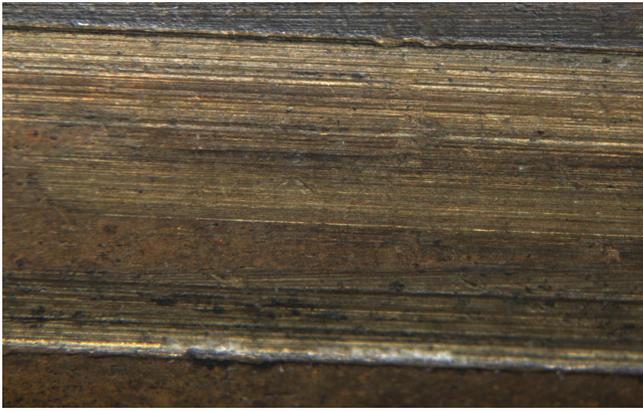


Figure 2. Land of fired .40 caliber bullet at 35x magnification

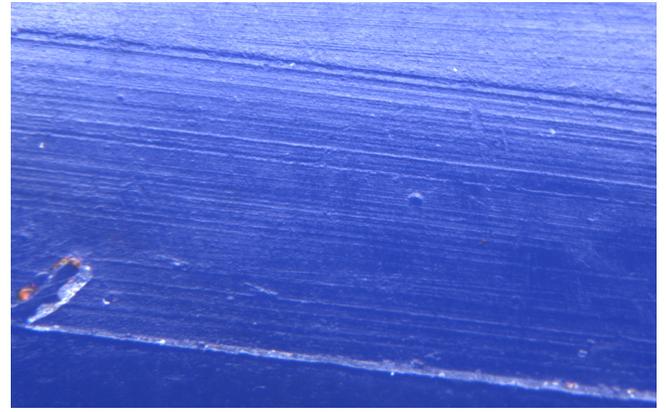


Figure 5. Land of 9mm fired bullet jeweler's wax cast at 35x magnification



Figure 3. Land of fired .40 caliber bullet Mikrosil® cast at 35x magnification

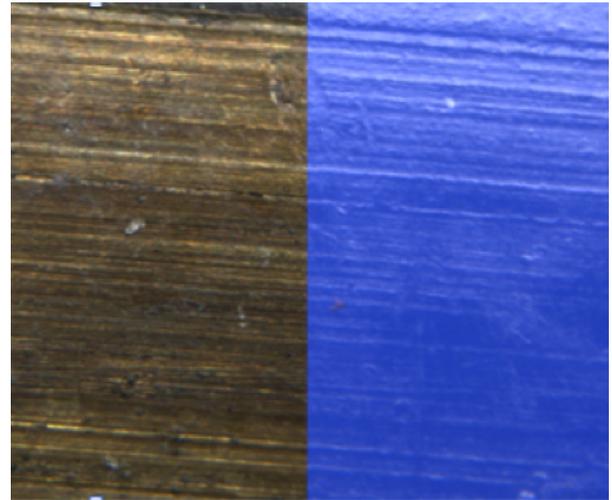


Figure 6. Matched lands of 9 mm fired bullet and 9mm fired bullet jeweler's wax cast

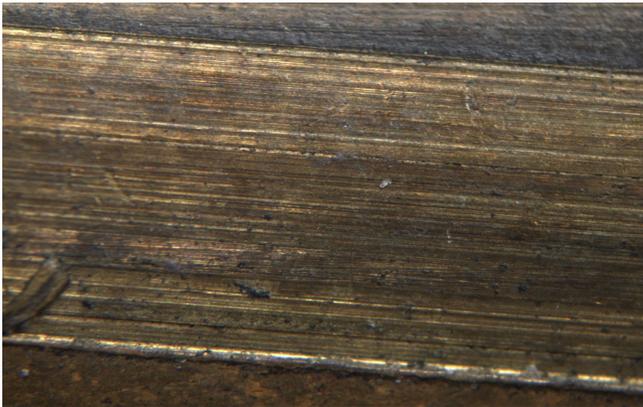


Figure 4. Land of 9mm fired bullet at 35x magnification

Number of Striations				
		Fired Bullet	Wax Bullet	% Recovery
Land	1	92	79	86%
	2	100	85	85%
	3	95	79	83%
	4	99	74	75%
	5	80	81	101%
	6	89	72	81%
Groove	1	22	21	95%
	2	30	16	53%
	3	29	23	79%
	4	27	25	93%
	5	46	42	91%
	6	46	37	80%

Table 1. Striations counted on each land and groove of a 9mm bullet and its jeweler's wax cast

## Discussion

Both the Mikrosil® casting putty and the TRITECHFORENSICS material were sufficient in making casts of fired bullets. The TRITECHFORENSICS material was more durable when the casts were inverted. The downside to this material was the color. The bright blue color of the TRITECHFORENSICS material led to less than ideal photographs. The striations were not visible in the lighting of the microscope. The casts were sufficient to make wax bullets, but the actual casts could not be properly examined. The Mikrosil® casting putty was great for making casts that could be microscopically examined. By freezing the metal bar, the occurrence of air bubbles was reduced and the quality of the cast was improved. This was most likely due to the longer drying time at the lower temperature. This allowed the Mikrosil® to settle in the microscopic striations. The metal bar was used as the best method to apply the Mikrosil® and TRITECHFORENSICS materials. The small openings in the metal bar forced the material into the small striations on the bullet's surface, thus removing the majority of the air bubbles.

These results show that the wax bullet does retain the majority of the striations from the fired bullet as seen in Table 1. As seen in Figure 5, the striations can be matched between the wax bullet and the fired bullet. The Mikrosil® and TRITECHFORENSICS Silicone Casting Material casts were negative images of the fired bullets and could not be directly compared. The wax bullet's lands and grooves were slightly smaller than the lands and grooves of the fired bullet. This may be because the Mikrosil® cast expands when the bullet is removed. To match the wax bullet to the fired bullet, the picture had to be expanded.

## Conclusion

Silicone castings of fired bullets may be useful in creating a double cast for comparison. Since the silicone castings are negative images of the actual bullet they cannot be used for direct comparison. Mikrosil® and TRITECHFORENSICS Silicone Casting Material are both suitable to make casts of fired bullets. The method of using Mikrosil® had to be changed from the manufacturer's directions. The material must be cooled to allow proper casting without air bubbles. Double castings made with wax are temporarily useful to be used for comparison. The surface of the wax is easily scratched, which destroys the striations.

This research needs to be continued. Due to time constraints only one bullet was counted for striations. For more information on the recovery of striations from these double cast bullets, more bullets need to be cast and counted. Further research needs to be done concerning bullet fragments and casting materials to see if striations can be recovered. Further research also needs to be done on a more permanent double casting material that will not be as easily destroyed as the wax bullets. This research could look into plastics and resins.

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## Biography



Kristen Fowble is a senior at the University of New Haven and will graduate in May 2014. She is a forensic science and chemistry double major. Kristen was a John Hatfield Scholar in her junior year. She is a tutor for the Forensic Science Living Learning Community and is also a teaching assistant for Organic Chemistry. Kristen is a captain of the UNH Dance Team. Kristen is a member of the Forensic Science and Chemistry Club, Honors Student Council, and American Chemical Society. She plans to attend graduate school for a forensics degree and hopes to work in a crime laboratory as a firearms evidence examiner.

