

Forensic examination of fired bullets and cartridge cases of 9 mm Luger imitation ammunition

Hsei-Chang Lee¹, M.Sc.; Hsien-Hui Meng^{2*}, Ph.D.

¹Firearms Section, Forensic Science Center, Criminal Investigation Bureau,
National Police Administration, Taiwan, R.O.C.

²Department of Forensic Science, Central Police University, 56 Shu Jen Road, Taoyuan 33304, Taiwan, R.O.C.

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Abstract

The illegal possession and criminal use of homemade ammunition is an important issue concerning public security in Taiwan. Two unusual types of imitation ammunition confiscated by police forces are studied in this work. Since the dimensions of the bullets of the imitation ammunition are significantly different from those of genuine ammunition with the same caliber, a further study is required to see if the fired bullets and cartridge cases of the imitation ammunition can be positively, unambiguously associated with the firearm discharged. Fired bullets and cartridge cases were recovered after test firings of imitation ammunition and genuine ammunition where the genuine ammunition was used as standard control. The tool marks left on each fired bullet and cartridge case were carefully examined and then microscopically compared with the ones on other bullets and cartridge cases fired through the same gun, respectively. All the comparisons of the fired genuine bullets and cartridge cases gave positive match. However, only firing pin impressions possessed sufficient individual characteristics for a conclusively positive identification, although a variety of tool marks were observed on fired imitation cartridge cases. The rifling marks on fired imitation bullets were much fainter than those on fired genuine bullets because the imitation bullets had smaller diameters. Thus, only two imitation bullets were positively identified to have been fired from the same pistol, where positive matches were also observed on the compared skid-mark areas. The rifling-mark comparisons on the rest of the fired imitation bullets all yielded inconclusive results. In conclusion, forensic firearms examiners should carefully differentiate imitation ammunition from genuine ones before doing ballistic comparison. When conducting ballistic comparison of fired imitation bullets and cartridge cases, every type of tool marks should be thoroughly scrutinized and compared to avoid missing any minor possibility of positive identification. Furthermore, the comparison results should be carefully interpreted to prevent false negative conclusions.

Keywords: firearms examination, imitation ammunition, ballistic comparison, rifling marks, firing pin impressions

Introduction

Homemade and converted ammunition are used in committing crimes in some countries [1-2]. Illegal possession of firearms and ammunition is also a threat to the public security in Taiwan. The official data reveal that more than thirty thousand rounds of illegal ammunition are confiscated by domestic law enforcement departments per year [3]. Among the varied types of homemade and converted ammunition, a category of ammunition so closely resembles genuine ammunition as to be called "imitation ammunition."

It is a kind of live ammunition and can be discharged through an industrially manufactured gun with a regular caliber. Therefore, it has high potential to kill people or inflict serious gunshot wounds when used as a substitute or genuine ammunition by criminals to commit a crime. Two unusual types of imitation ammunition confiscated in two criminal cases are studied in this work, i.e., AP 03 9 MM LUGER and WIN 9 mm LUOER, as classified based on their different head stamps (Fig. 1).

*Corresponding author: una106@mail.cpu.edu.tw

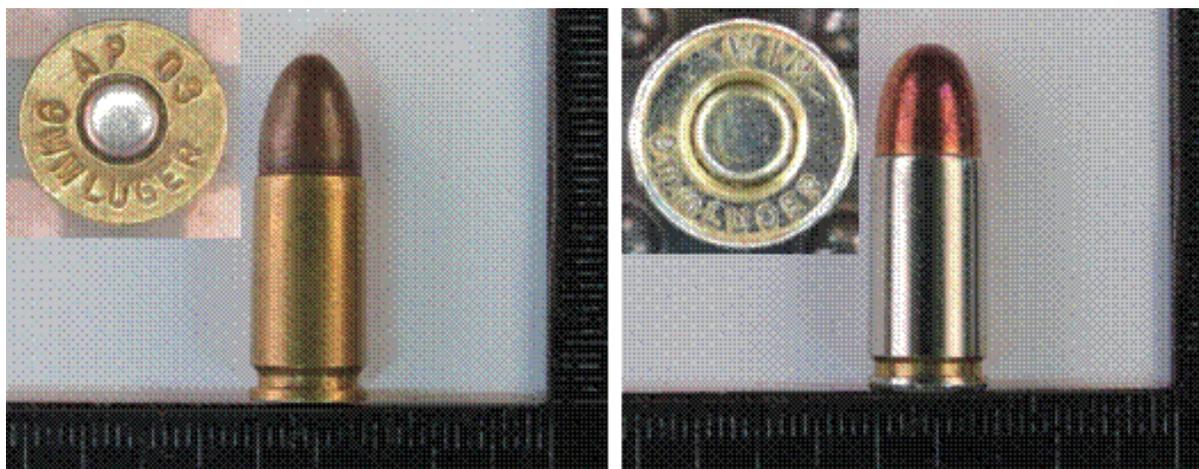


Fig.1 The appearances and head stamps of two different types of imitation ammunition: AP 03 9 MM LUGER (left) and WIN 9 mm LUOER (right).

The comparison of marks on fired bullets and spent cartridge cases is a useful way for firearms examiners to make a positive association between fired ammunition and a specific firearm or to exclude a suspected gun [4-6]. Successful comparison can often be achieved after firing genuine ammunition and firearms. However, since the dimensions of the bullets of the imitation ammunition are significantly different from those of the genuine ammunition with the same caliber [7], a further study is required to see if the fired bullets and cartridge cases of the imitation ammunition can be positively associated with the firearm discharged. Hopefully, the results of this study may be helpful for the firearms experts to interpret their findings in ballistic comparison of fired bullets and cartridge cases of imitation ammunition.

Materials and methods

Research equipment

1. Leica DMC comparison microscope with Nikon E995 digital camera.
2. A Taurus Model PT 99 AF 9 mm Luger semi-automatic pistol from reference collection.
3. Fuji FinePix S9600 digital camera.
4. Mitutoyo caliper.
5. Water tank.

Research material

Two types of 9 mm Luger imitation ammunition and one type of 9 mm Luger industrially manufactured ammunition which was used as control samples were test fired and their fired bullets and cartridge cases were subjected to ballistic comparison. The designated sample names, head stamps of ammunition, sample size, and mean values of bullet diameters of each type of ammunition are summarized in Table 1.

Table 1. Sample names, head stamps, sample sizes, and mean values of bullet diameters of the studied ammunition

Sample name	Head stamp	Sample size (rounds) [†]	Mean value of bullet diameter (mm)
IA	AP 03 9 MM LUGER	8	8.80
IW	WIN 9 mm LUOER	2	8.76
GR	RAI 06 9 MM LUGER	3	8.98

[†]“Sample size” stands for the amount of ammunition studied.

Methods

All the bullets of the imitation ammunition and genuine ammunition were fired into a water tank using the same Taurus PT 99 AF 9 mm semiautomatic pistol. The fired bullets were recovered from the water after each test firing for further examination.

The appearances of the fired cartridge cases of imitation ammunition were examined to find any deformations. Various types of tool marks left on the cartridge cases of imitation and genuine ammunition during discharging process were carefully examined. Various types of marks on the imitation and genuine ammunition cases were compared with each other employing a comparison microscope.

The appearances of all the fired bullets were examined to find any deformations or jacket-core separations. The number and configuration of rifling marks engraved on each fired bullet was carefully examined. The microscopic striations of rifling marks on the fired imitation and genuine bullets were compared with each other employing a comparison microscope. The criterion for a positive identification of two toolmarks defined by the Association of Firearms and Toolmarks Examiners is: Agreement of a combination of individual characteristics and all discernable class characteristics where the extent of agreement exceeds the best agreement demonstrated between tool marks known to have been produced by different tools and is consistent

with agreement demonstrated by toolmarks known to have been produced by the same tool [8]. This criterion is followed in this study, thus the interpretation of a positive identification is based on the author's education, training, and experience.

Results and Discussion

The comparison of spent cartridge cases

When a round of ammunition is fired the cartridge case will expand to seal the chamber against rearward escape of combustion gases. If the cartridge case is properly sized corresponding to the chamber and tempered to the correct hardness, it will spring back to its original dimensions after firing. Because homemade ammunition often have undersized cartridge cases or soft case materials, it is not unusual to find over expanded cartridge case when homemade ammunition is fired in a genuine gun. However, no expanded deformation was observed on any spent imitation cartridge cases in this study. This was attributed to the materials, the outer diameters, and the lengths of the imitation cartridge cases being in good accordance with those of genuine ammunition and thereby avoiding the deformation of the cartridge cases by the extremely high pressure of combustion gases. The appearances of the lateral side and the base of a spent imitation cartridge case are shown in Fig. 2.



Fig.2The appearances of the lateral side (left) and the base (right) of a spent imitation cartridge case.

Firing pin impressions, breech-block marks, ejector marks, and extractor marks are found on all the spent genuine and imitation cartridge cases. However, with the exception of firing pin impressions all the rest of the marks observed on the spent imitation cartridge cases were too faint or did not have enough individual features for positive identification. For the spent casings of genuine ammunition, i.e. GR ammunition, both firing pin impressions and breech-block marks have enough individual features for comparison. Every kind of mark mentioned above on one spent imitation cartridge case (IA1) was compared with that of every other spent casing of IA, IW, and GR ammunition under comparison microscope. The spent cartridge cases of three rounds of genuine ammunition were compared with each other as standard controlled experiments. The results of microscopic comparison are shown in Table 2. Only the firing pin impression comparisons gave straight positive matches on all the compared pairs of cases. The pairwise comparisons of the ejector marks and extractor marks on all the cases led only to inconclusive results. All the breech-block mark comparisons between genuine cartridge cases gave positive match. In contrast, all the breech-block mark comparisons between IA1 cartridge

case and all the other imitation and genuine cases were inconclusive. An example each of the inconclusive comparisons of ejector marks, extractor marks and breech-block marks on an imitation case and a genuine case is shown in Figs. 3, 4, and 5, respectively. The inconclusive results of breech-block mark comparisons were attributed to the undersized bullets of imitation ammunition. When an undersized bullet is fired through a normal barrel, due to the leakage of gases, proper gunpowder combustion does not take place, which diminishes the development of complete chamber pressure. As a result, the fired cartridge case is thrust back to strike the breech face under a much smaller backward force which further results in faint breech-block marks and inconclusive comparisons. Since the formation of the firing pin impressions is not influenced by the chamber pressure, positive match results can always be achieved provided that the tip of the firing pin possesses sufficient unique characteristics. Fig. 6 shows a typical positive match of firing pin impressions on an IW and a GR cartridge cases. These results indicate that the firing pin impressions are the only type of tool marks that can be effectively used to associate a spent imitation cartridge case to a discharged gun.

Table 2. The results of tool marks comparison of spent cartridge cases †,*

Sample names of compared pair	Breech-block marks	Firing pin impressions	Extractor marks	Ejector
IA1 / IA2	—	+	—	—
IA1 / IA3	—	+	—	—
IA1 / IA4	—	+	—	—
IA1 / IA5	—	+	—	—
IA1 / IA6	—	+	—	—
IA1 / IA7	—	+	—	—
IA1 / IA8	—	+	—	—
IA1 / IW1	—	+	—	—
IA1 / IW2	—	+	—	—
IA1 / GR1	—	+	—	—
GR1 / GR2	+	+	—	—
GR1 / GR3	+	+	—	—

* A “+” sign represents a positive match.

† A “—” sign stands for an inconclusive result.



Fig.3 An inconclusive comparison image of ejector marks on an imitation (right) and a genuine (left) cartridge case.



Fig.4 An inconclusive comparison image of extractor marks on an imitation (right) and a genuine (left) cartridge case.

The comparison of fired bullets

The diameter of a bullet is slightly larger than the bore diameter of the barrel through which the bullet is designed to be fired. In this study, the bore diameter of the pistol used is 8.76 mm which is smaller than the diameters of GR and IA ammunition (8.89 mm and 8.80 mm, respectively) and is equal to that of IW ammunition. Thus, when a bullet is fired through the rifled barrel, negative impressions of rifling features will be impressed on the bullet. Because the diameters of genuine bullets were more significantly larger than the bore diameter of the test fired pistol, rifling marks with sufficient individual striations were observed on all the fired genuine bullets, and hence all straight positive matches. A typical comparison image of positive match between two fired genuine bullets is shown in Fig. 7.



Fig.5 An inconclusive comparison image of breech-block marks on an imitation (right) and a genuine (left) cartridge case.

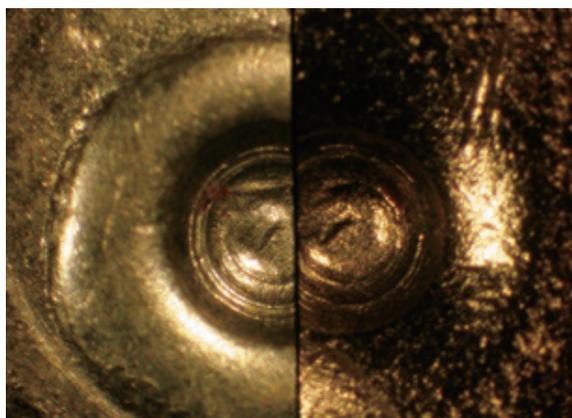


Fig.6 A typical positive match of firing pin impressions on an imitation (right) and a genuine (left) cartridge cases.

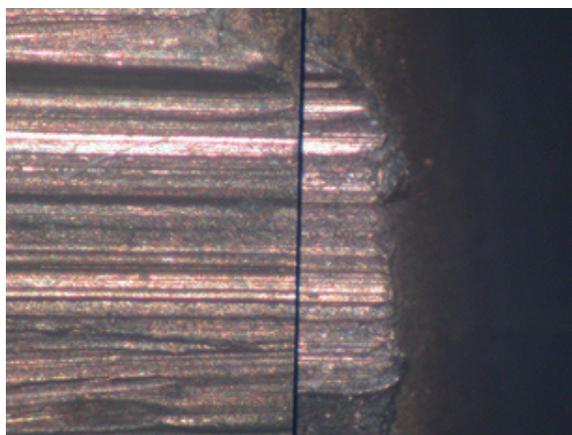


Fig.7 A typical match of rifling mark comparison between two fired genuine bullets: GR1 (right) and GR2 (left).

During the test firing process it was observed that the lead cores of the imitation bullets had the tendency to be squeezed out of the metal jackets. This phenomenon was attributed to the unusual configuration of imitation bullet where the base of the lead core was entirely exposed and not protected by the jacket at the circumference of the base as shown in Fig. 8. The separation of lead core and metal jacket could lead to the misidentification of a lead core as a bullet because the core might get impressed with very faint “rifling” marks on it through the jacket. In addition, these marks were class features rather than individual features, rendering a

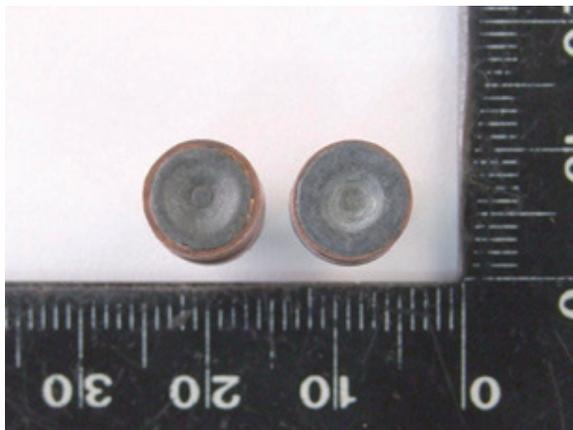


Fig.8 The circumferences of the lead core base of an IW bullet (left) and an IA bullet (right) are exposed.

are much fainter than those on fired genuine bullets, the land impressions and groove impressions on IA bullets are still distinguishable and countable. But the land impressions and groove impressions on IW bullets are so faint as to be indistinguishable from each other. Fig. 11 shows the rifling patterns of fired GR, IW, and IA bullets. The IA bullets have one groove near the middle of the bullet body where the cartridge case mouth is crimped into. The bullet body below the groove has smaller diameter than that above the groove and this leads to even fainter rifling pattern on the lower part of fired IA bullets.

On the other hand, because the IW bullets have a diameter equal to the bore diameter of the fired pistol, the IW bullets will not be properly directed by the lands of rifling in the barrel when the ammunition is fired. This results in not only the loose contact between the bullet and the barrel but also the skid of the bullet while it passes through the barrel. As a result, shallow rifling marks which tail to the right on the area close to bullet

microscopic comparison inconclusive. Conversely, with a genuine bullet, the circumference of the base of lead core is enclosed by metal jacket to prevent the lead core from being squeezed out of the jacket when impacting the target (Fig. 9). It follows that the insufficient, if any, protecting function of the metal jacket of the imitation bullet resulted in the separation of the lead core from the jacket during the test firing. Fig. 10 shows an example of separated metal jacket and lead core that originate from the same fired bullet, where the deformation of jacket is also discernible.

Although the rifling marks on fired imitation bullets

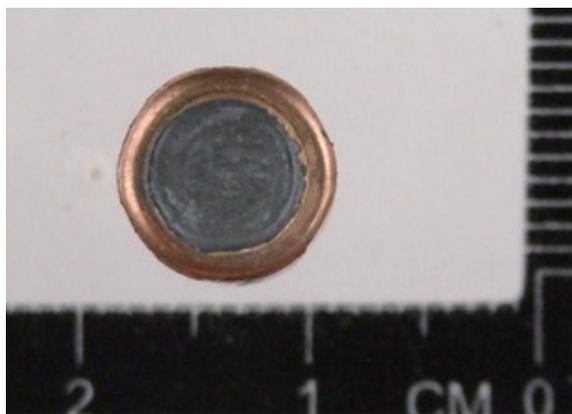


Fig.9 The circumference of the lead core base of a GR bullet is enclosed by the metal jacket.



Fig.10 A separated metal jacket (left) and lead core (right) of a fired imitation bullet.

tip are formed as shown in Fig. 12. Sometimes the skid and unstable spin of the bullet results in different rifling impressions with varied tilt angles on the same fired bullet as shown in Fig. 13.



Fig.11 The rifling patterns on fired GR (top left and right), IW (bottom left) and IA (bottom right) bullets.

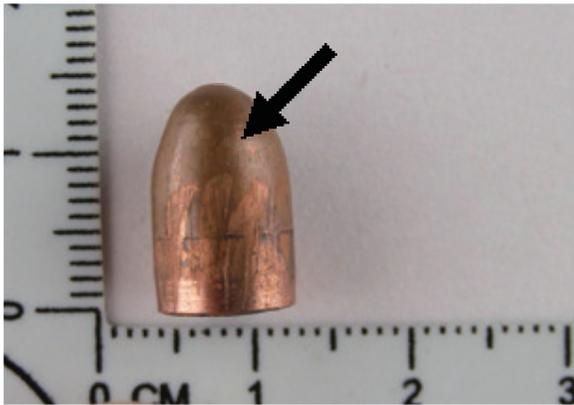


Fig.12 The top of the rifling marks on a fired IW bullet tails to the right as indicated by the arrow.



Fig.13 Different rifling impressions with varied tilt angles formed on the same fired IW bullet as indicated by the arrows and lines.

Sufficient individual characteristics were observed on the land engraved impression on all the fired genuine bullets. Thus, all the ballistic comparisons of rifling marks between fired genuine bullets gave positive match. One typical microscopic image of positive match of rifling marks between two fired genuine bullets is shown in Fig. 7. In contrast, among the ten fired imitation bullets, only two IA bullets were positively identified to have been fired from the same barrel, where positive match were also observed on the examination of the skid-mark areas as shown in Fig. 14. For the rest of the fired IA bullets and both of the fired IW bullets, the rifling marks always lacked enough individuality to permit a valid comparison. Thus, the ballistic comparisons of rifling marks between these fired imitation bullets are all inconclusive. For an inexperienced firearms examiner these inconclusive results might be mistakenly

interpreted as an exclusion of identification. Fig. 15 shows a typical microscopic image of inconclusive result of a ballistic comparison between imitation and genuine bullets.

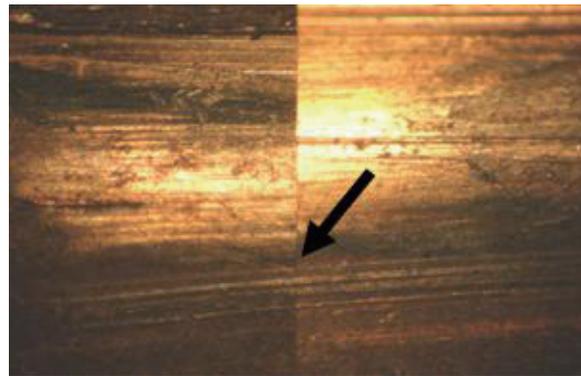


Fig.14 Positive match of skid marks on bullets IA1 and IA7 as indicated by the arrow.

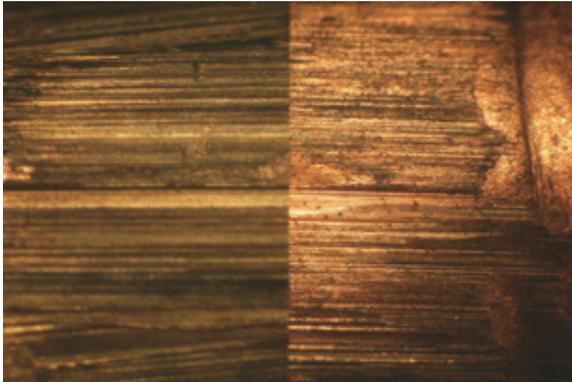


Fig.15 An inconclusive rifling-mark comparison between an IW (right) and a GR (left) bullets.

Conclusions

Although the studied imitation ammunitions were indistinguishable from genuine ammunition at the first glimpse, their dimensions and configurations were often different. These variations would probably result in faint tool marks impressed on the fired cartridge cases and bullets. However, among a variety of tool marks left on the fired cartridge cases, only firing pin impressions had sufficient individual characteristics for the purpose of positive identification via ballistic comparison. The situation was even worse for fired imitation bullets where only two out of ten bullets fired through the same gun were positively identified after microscopic comparison of rifling marks. Thus, forensic firearms examiners should carefully examine the appearance of ammunition evidence to differentiate imitation cartridges from genuine ones before carrying out any test firings and ballistic comparisons. While conducting ballistic comparison of fired imitation bullets and cartridge cases, every type of tool mark should be thoroughly scrutinized and compared to avoid missing any minor possibility of positive identification. Furthermore, the comparison results should be carefully interpreted to prevent false negative conclusions.

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