Federal's New Syntech™ Ammunition: Properties of Forensic Interest

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Keywords: bismuth, Catalyst™ primers, Doppler radar, exterior ballistics, Federal Cartridge Company, firearms identification, GSR, gunshot residue, Herter's Total Nylon Jacket™, Nyclad™, P-GSR, polymer-coated bullets, Syntech™, TNJ™ TSJ™

ABSTRACT

A new ammunition product line from the Federal Cartridge Company, Anoka, MN was displayed at the 2016 SHOT Show in Las Vegas, Nevada. Presently available in 9mm Luger, .40 S&W and .45 Automatic, the bright red polymer-coated projectiles are loaded in brass, Boxer-primed cartridge cases containing heavy metal-free primers. The Syntech trademark and TSJ (Total Synthetic Jacket) designations refer to the complete encapsulation of an underlying lead projectile. The intended purpose is for use in ranges to reduce airborne lead. The cartridge boxes also advertise reduced friction, the elimination of lead and copper fouling, extended barrel life and improved accuracy.

Initial testing utilized samples in 9mm Luger and .40 S&W which were discharged in conventionally rifled and polygonally rifled pistols, and the fired bullets recovered from water and ballistic soap. The polymer jackets survived these internal and terminal ballistic events with minimal damage and loss. Subsequent testing was carried out on the .45 Automatic version of this novel ammunition once it became available. The barrel markings on the bearing surfaces of these bullets were limited to the general rifling characteristics. No striae suitable for firearms identification were observed on the test-fired specimens collected in this study, nor were any visible residues of the bright red polymer coating observed in the bores of the test firearms. An examination of bullet wipe rings produced by these bullets in tightly woven cloth mounted on a soft tissue simulant also failed to show any visible red residues.

Introduction

While at the 2016 SHOT Show, this writer's attention was captured by a new product line at the Federal Cartridge Company's booth where some pistol ammunition was on display which was loaded with what could best be described as lipstick red bullets. This turned out to be Federal's new *Syntech*™ ammunition in 9mm Luger and .40 S&W loaded with polymer-coated *TSJ*™ (Total Synthetic Jacket) bullets weighing 115 grains in 9mm and 165 grains in .40 S&W. The .45 Automatic version was not on display in January of 2016, but was being advertised by July 2016. Samples of the *Syntech* .45 Automatic ammunition, loaded with 230 grain round nose bullets, were ultimately obtained in November 2016 and were subsequently included in this project.

The promotional literature for this ammunition described its purpose as for use in shooting ranges to reduce airborne lead. It also advertised reduced friction, the elimination of lead and copper fouling, extended barrel life and improved accuracy.

Realizing that someone will ultimately use or misuse this new and unconventional ammunition in an event which will bring it to the attention of forensic firearms examiners, it was deemed desirable to acquire and study this ammunition from a forensic viewpoint.

Date Received: August 22, 2017
Primary Review Completed: November 28, 2017
Secondary Review Completed: February 8, 2018

The kind assistance of Larry Head, Director/Chief Engineer, Ammunition Systems-Product Engineering at Vista Outdoor, Anoka, Minnesota, was obtained, and in March 2016, this writer received a 50-round box each of the 9mm and .40 S&W ammunition. **Figures 1a** and **1b** show the top and backside of these boxes. The box end flaps for all three calibers are depicted in **Figure 1c**. Intact and disassembled 9mm and .40 S&W cartridges are shown in **Figure 2**. The headstamps on the March 2016 samples are depicted in upper half of **Figure 3**. The 9mm headstamp is somewhat unusual in that it possesses two large, indented dots on either side of the 'FC' and a third, large indented dot between the 9MM and LUGER. The numeral '9' also has an odd shape. The .40 S&W and .45 Auto headstamps are unremarkable with one exception; the Federal .45 Auto cartridges purchased in November of 2016 contain small pistol primers (lower half of **Figure 3**).

Testing Procedures and Results

The first subjects of interest were the muzzle velocities these projectiles achieved from representative handguns in each caliber followed by the stability of these bullets in flight. These parameters were determined with the author's *Infinition*

Figure 1a: Top of ammunition boxes

Figure 2: Intact and disassembled 9mm and .40 S&W cartridges

Figure 1b: Backside of ammunition boxes

Figure 3: Samples of headstamps (upper). Small pistol primer on Federal .45 Auto cartridge (lower)

Figure 1c: Box end flaps

Doppler radar system and six pistols: a 9mm Glock 17, a 9mm Beretta 92FS, a .40 S&W Glock 23, a .40 S&W Beretta 96, a .45 Auto Glock 21 and a .45 Auto SIG/Sauer P220. These pistols were chosen because of their very different rifling systems; polygonal for the Glocks and conventional 6-right (with sharp driving edges) for the Berettas and the 6-left for the SIG/Sauer. One could hypothesis that the very slick polymer coating on these bullets might not allow adequate spin stabilization (due to possible slippage) by the smooth, polygonal surfaces of the Glock barrels. Conversely, the aggressive, conventional rifling in the Beretta and SIG/Sauer pistols might cut through the polymer coating, breaking some of it loose and resulting in an unstable flight or diminished ballistic coefficient. Two additional benefits of the Doppler system are that muzzle velocity values can be derived as well as the effective ballistic coefficients of these bullets when

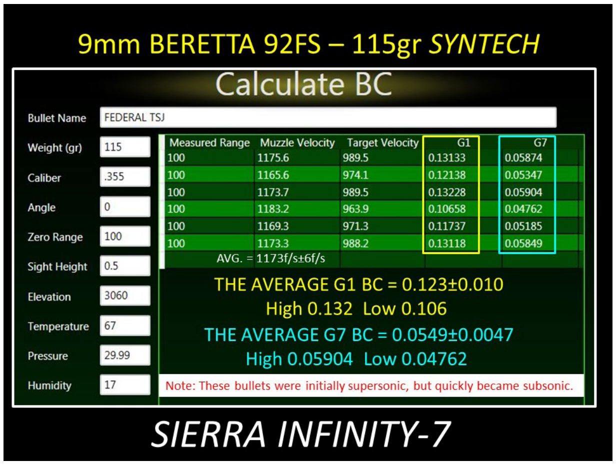
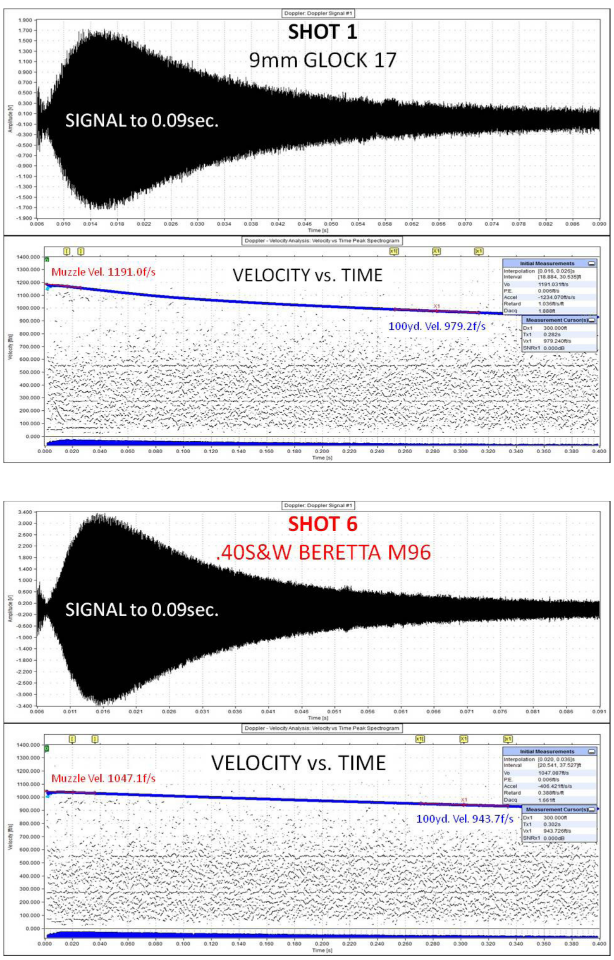


Figure 4: Sierra Bullets' *Infinity-7* exterior ballistics program



Figures 5a and 5b: Examples of Doppler radar tracks

launched from the two different rifling systems. Six rounds from each of the six pistols were tracked out to 150 yards. The velocity values at 100 yards along with the muzzle velocity values were used in each case to calculate the effective G1 and G7 ballistic coefficients. This was accomplished with Sierra Bullets' *Infinity-7* exterior ballistics program [1]. An example from this program is depicted in **Figure 4**.

The Doppler radar tracks showed spin-stabilized flights for all shots with no clear evidence of instability. Two representative examples are provided in **Figures 5a** and **5b**. **Table 1** summarizes the results for the Doppler radar tests for the 9mm and .40 S&W cartridges in both firearm types and the .45 Auto results for the Glock 21. Conventional 230-grain full metal-jacketed .45 Automatic bullets in Winchester military ammunition (1967 headstamp) fired from the SIG P220 and tracked under the same conditions yielded an average G1 BC of 0.152±0.010 for five shots which is in very close agreement with the result of 0.153±0.005 obtained for the 230-grain *Syntech* bullet.

Three additional shots with the 9mm and .40 caliber pistols were discharged through heavy paper, backed by cardboard witness panel, located 20 feet downrange as another measure of bullet stability (round bullet holes vs. ovoid bullet holes), and as a means of recording and subsequently testing of "bullet wipe". The witness panels from these tests are depicted in **Figures 6a** and **6b**. The velocity values shown in these figures were obtained from a CED chronograph positioned approximately 10 feet beyond the muzzles of the pistols. Visible "bullet wipe" can be seen around the margins of all of the bullet holes. However, *no* red polymer residues were observed in any of the "bullet wipe" deposits when subsequently examined under the stereo-microscope. The same results were obtained for the .45 caliber *Syntech* bullets, but have not been reduced to an additional illustration in this article. No red deposits of the plastic polymer were observed in the bores of these six pistols after a total of 14 shots from each pistol, nor when their bores were inspected in strong sunlight and under a stereo-microscope.Shots through cotton cloth also produced "bullet wipe", but no visible transference of the red plastic polymer.

Recovered Bullets

Multiple 9mm, .40 caliber, and .45 caliber bullets were fired into a water recovery tank with the same set of pistols used for the Doppler radar measurements. One round each was also fired into a 14 inch long block of ballistic soap backed by a panel of Kevlar. All of these bullets perforated the block of ballistic soap without expansion or deformation, and were recovered intact from the Kevlar panel.

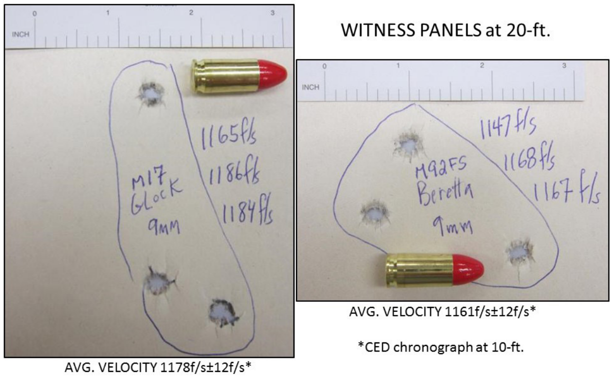


Figure 6a: 9mm witness panels

Figure 7a: 9mm bullets

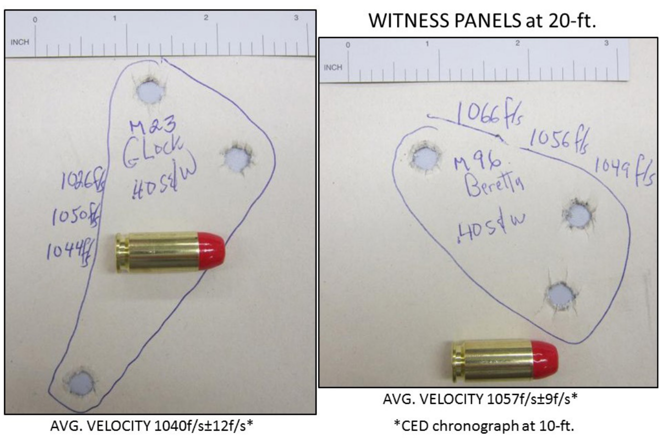


Figure 6b: .40 S&W witness panels

Figure 7b: .40 S&W bullets

The 9mm bullets appear in **Figure 7a** and the .40 caliber bullets in **Figure 7b**. As can be seen, the polymer coating remained adhering to the bearing surfaces of all of these bullets with only small areas of dislodged polymer. These small breaches in the polymer revealed the underlying lead core which possessed a pebble finish; a texture clearly intended to aid in the bonding of the polymer coating. Moreover, the conventional rifling in the Beretta pistols did *not* cut through the polymer coating, nor did passage through the 'soft-solid' block of ballistic soap result in any removal of any significant amount of the polymer coating. A closer view of a test-fired bullet from the 9mm and .40 caliber pistols is provided in **Figure 8**.

The 6-right conventional rifling in the two Beretta pistols can clearly be seen engraved in the bullets from these pistols. Typical polygonal rifling marks can also be seen on the bullets from the two Glocks. Comparable results were obtained with the two .45 Auto pistols, but are not shown here.

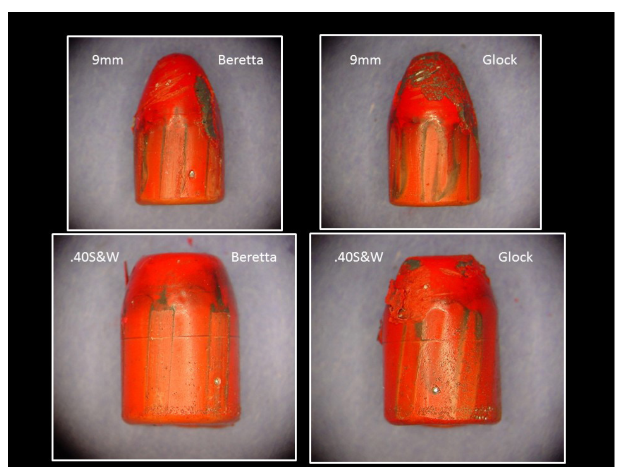


Figure 8: Test fired bullets from 9 mm and .40 S&W pistols

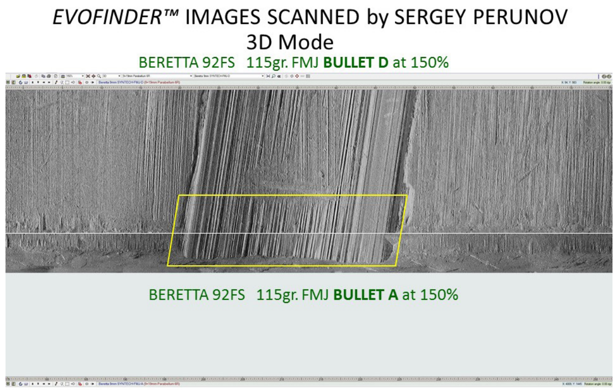


Figure 9a: Jacketed bullets from Beretta pistol

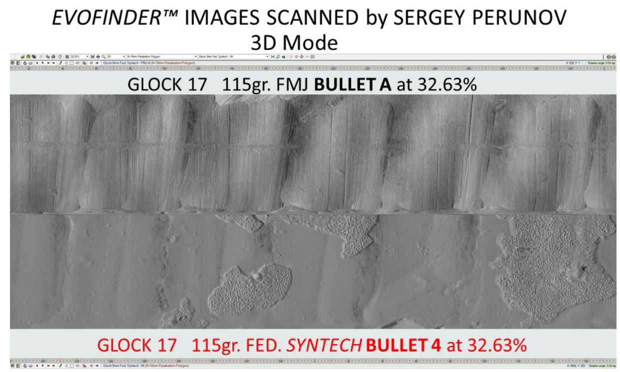


Figure 9c: Jacketed and *Syntech* bullets from Glock pistol

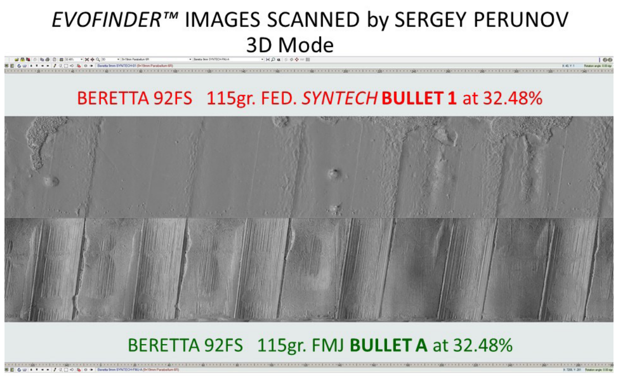


Figure 9b: *Syntech* and jacketed bullets from Beretta pistol

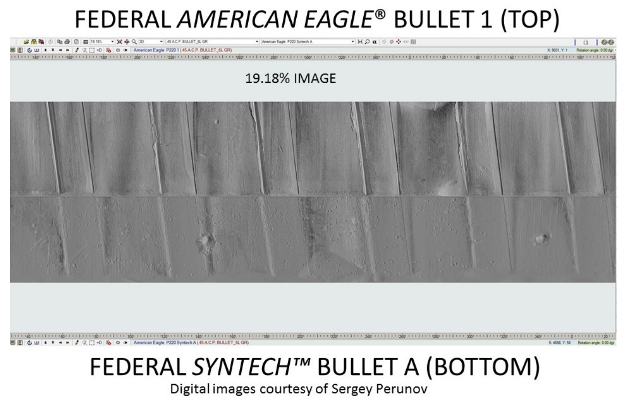


Figure 9d: Jacketed and *Syntech* bullets from SIG/Sauer pistol

Firearms Identification

Examination and comparison of the recovered *Syntech* bullets verses traditional gilding metal (GM) jacketed bullets fired from four of these pistols revealed that the GM bullets from the Berettas were easy to match among themselves. Only agreement in general rifling characteristics was observed with the GM bullets from the three Glocks, which was as expected. No striae were observed on the *Syntech* bullets from any of the six pistols when the recovered bullets were mounted on the comparison microscope and illuminated with high intensity fluorescent lighting. There was, however, close agreement between *Syntech* bullets and GM bullets in the *widths* of the traditional land impressions in the 9mm and .40 caliber bullets fired from the conventionally-rifled Beretta pistols and the .45 caliber bullets fired from the SIG/Sauer pistol. As expected, there were no clearly defined edges to the land impressions produced by the Glock pistols on both GM jacketed bullets and the *Syntech* bullets. These results for the *Syntech* bullets represent a departure from those with the original *Nyclad* bullets reported in the July 1979 issue of the AFTE Journal [2]. Examples of matching striae patterns on test-fired *Nyclad* bullets from a Smith & Wesson .38 Spl. revolver and a Ruger .357 Magnum revolver were described and illustrated in that article. This remains true as of 2017 with the appearance of Herter's *Total Nylon Jacket* ammunition by Blazer.

The *Syntech* and conventional bullets produced by this author were submitted to Sergey Perunov for scanning with the *Evofinder* system in an effort to reveal any vestiges of barrel-generated striae on the *Syntech* bullets. The digital image files were returned to this writer, and studied at length. The matching of jacketed bullets was straightforward. An inspection of **Figure 9a** provides an excellent example, and illustrates the author's reason for choosing a Beretta pistol as a firearm most likely to impart striae to a *Syntech* bullet. The best specimens of the *Syntech* bullets from the 9mm Beretta along with the corresponding GM jacketed bullets are shown juxtaposed in **Figure 9b**. A comparable comparison for a 9mm *Syntech* bullet and a conventional jacketed bullet from the Glock 17 is depicted in **Figure 9c**. **Figure 9d** provides the same sort of comparison for a full metal-jacketed bullet and a .45 caliber *Syntech* bullet fired from a SIG/Sauer P220

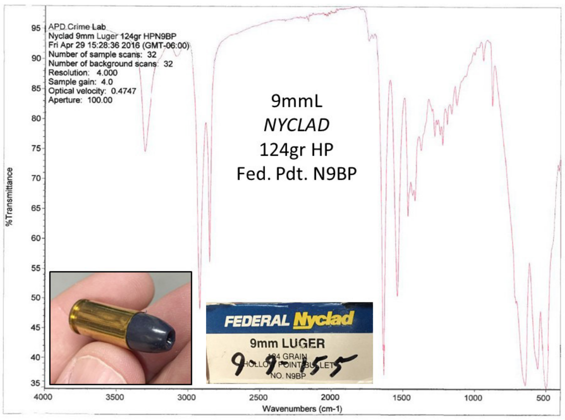


Figure 10: Infrared spectral analysis for a 9mm *Nyclad* bullet

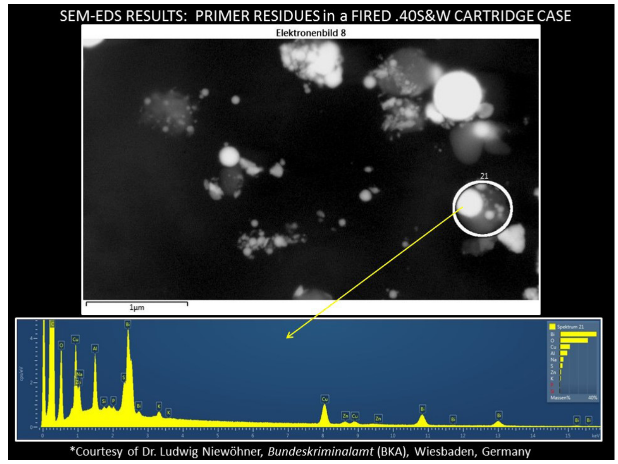


Figure 12: SEM-EDS results for fired primer residues from a discharged cartridge case

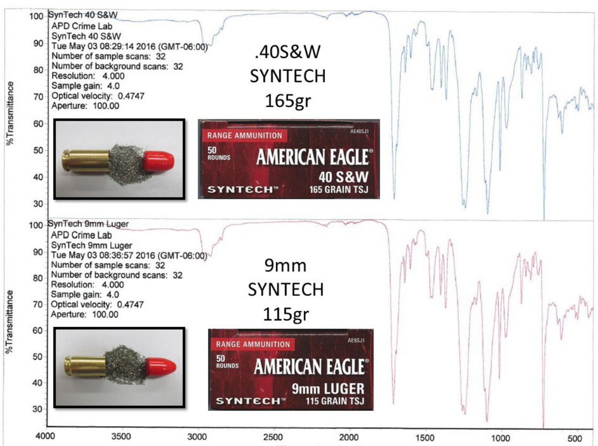


Figure 11: Infrared spectra from the .40 S&W and 9mm *Syntech* bullets

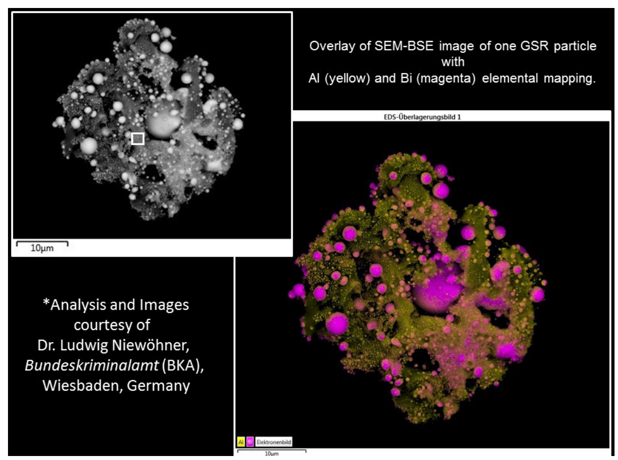


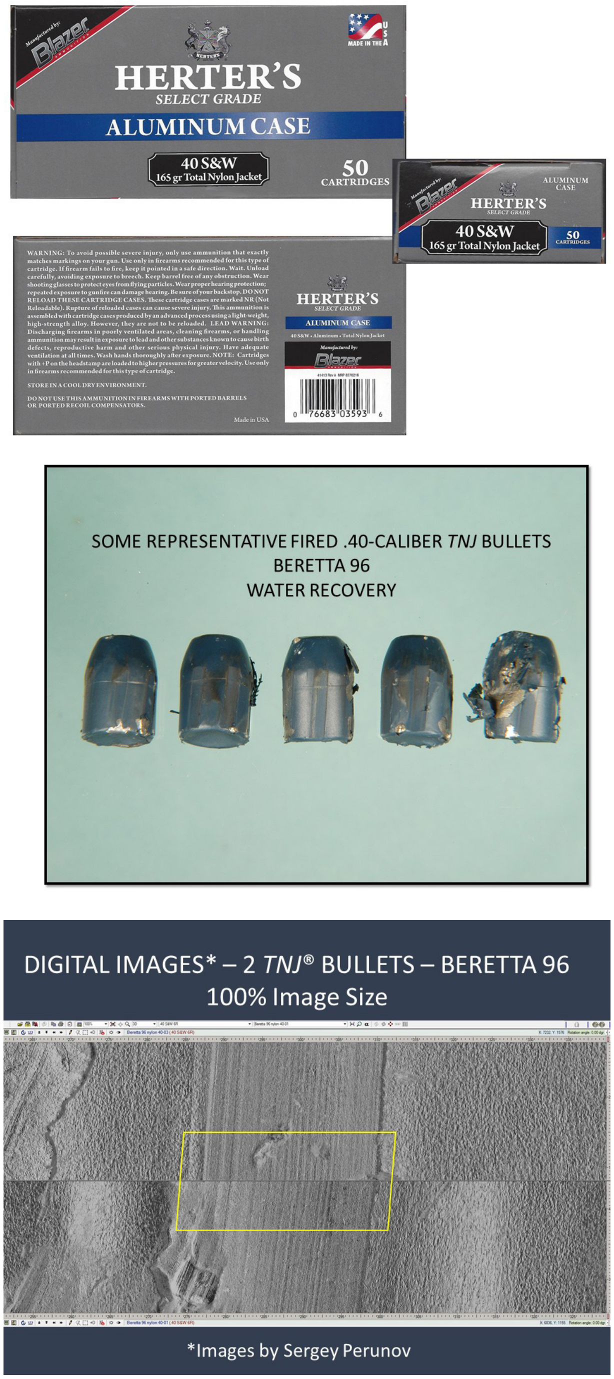
Figure 13: Colonized version of a P-GSR particle

pistol. These figures readily illustrate the total absence of any striae in the polymer coatings on the three calibers of *Syntech* bullets.

Composition and Chemical Aspects

The external polymer coating on unfired specimens of the *Syntech* bullets along with a number of 9mm and .38 Spl. *Nyclad* bullets were analyzed by FTIR spectroscopy by Michael Haag at the Albuquerque Forensic Science Center in Albuquerque, New Mexico. *Nyclad* ammunition was a product relatively well known in the 1970s and 1980s. The results of the infrared spectral analyses on multiple *Nyclad* bullets presented no surprise; a form of Nylon which most closely agreed with a library reference spectrum of *Nylon 11*. **Figure 10** provides an example of the results for a 9mm *Nyclad* bullet. The infrared spectra derived from the 9mm and .40 S&W *Syntech* bullets were easily distinguished from that of the *Nyclad* bullets (**Figure 11**). The *Syntech* polymer most closely agreed with poly(butylene terephthalate)- a polymer commonly used in the coating of electrical wiring. This coating was also found to be insoluble in all common solvents (ethyl and isopropyl alcohol, acetone, chloroform, toluene, hexane, dioxane, and dimethylsulfoxide).

The heavy metal-free *Catalyst*™ primers in these cartridges presented a real surprise. Fired and unfired primers, analyzed by Dr. Ludwig Niewöhner at the German BKA Laboratory in Wiesbaden, Germany, were found to contain bismuth, a constituent heretofore not seen in small arms primer compositions. At present, this amount to a *signature* element for any Federal brand ammunition loaded with this novel primer. **Figure 12** shows Dr. Niewöhner's SEM-EDS results for fired primer residues from a discharged cartridge case. **Figure 13** depicts a colorized version of a P-GSR (Primer-



Figures 14a, 14b, 14c: Herter's *Total Nylon Jacket*™ (TNJ) ammunition by Blazer

Gunshot Residue) particle in which aluminum and bismuth have been assigned colors.

The chemistry of bullet wipe produced by this ammunition was also investigated by means of the *Midex II* system described previously in the reference listed at the end of this article [3]. The 'signature' element, bismuth, along with aluminum was detected in a bullet wipe sample produced in cotton cloth by one of the .40 caliber *Syntech* bullets. Although visible evidence of the red polymer was absent in bullet wipe samples and the bores of the six firearms used in these tests, Dr. Niewöhner's results on bullet wipe would strongly indicate equal success could be realized on bore residues. A recent AFTE article by Robert Berk and Aaron Horn demonstrate this when they identified the signature element, cobalt, in the bore of a revolver through which *Nyclad* bullets had been fired [4].

Summary

Federal's new *Syntech* pistol ammunition is *not* a re-introduction of the historic *Nyclad* product line first introduced in the mid-1970s, and recently re-introduced in Herter's *Total Nylon Jacket*™ (*TNJ*) ammunition by Blazer (**Figures 14a**, **14b** and **14c**). **Figure 14c** is particularly noteworthy because it shows that striae suitable for identification purposes can be imparted to these Nylon-coated bullets. The color and chemistry of the *Syntech* polymer coating is entirely different from that of the old and the new *Nylon*-coated bullets. The heavy metal free *Catalyst*™ primer mixture employed in the *Syntech* ammunition is presently unique due to its bismuth content which amounts to a signature element at this time.

The *Syntech* ammunition is presently unique, both in its bright red polymer coating, and its heavy metal-free primer composition. The infrared spectrum of this polymer, provided in this article, stands to be useful to those examiners who have access to an IR spectrophotometer, and who are presented with a case in which particles of a bright red plastic are associated with a probable or known bullet impact site. The polymer remains relatively well bonded to these bullets during discharge leaving no visible transfers on the rifling of any of the six handguns employed in these tests or in bullet wipe on clothing. Depending on the nature of the target, small portions of the polymer coating may be dislodged from the lead core of a *Syntech* bullet. Such trace evidence would, of course, be suitable for non-destructive analysis and identification by FTIR spectroscopy. Transfers of the red polymer coating have been seen with ricochets from automotive sheet metal and stepping stones made of various abrasive materials such as concrete and sandstone. An example is provided in final **Figure 15**.

Based on the tests conducted by Dr. Niewöhner and his colleagues at the BKA, it may be possible to detect traces of bismuth in bullet wipe and/or close-range gunshot residue deposits.

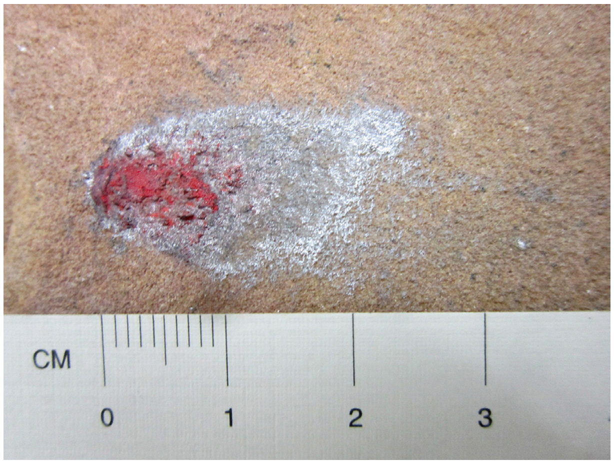


Figure 15: Transfer of red polymer coating

Forensic firearms examiners will be able to ascertain the general rifling characteristics of the firearm from which one or more of these bullets was discharged, but individual characteristics will very likely be absent based on the tests performed in this study. This is in contrast to *Nyclad* and Herter's *TNJ* bullets where barrel-generated striae in the Nylon coating are possible.

Doppler radar tests and the appearance of bullets holes in downrange witness panels showed that the *Syntech* bullets are adequately spin-stabilized by conventional rifling and polygonal rifling with no evidence of slippage or stripping of the polymer coating. Nominal muzzle velocities for the three calibers of bullets from the six handguns used in these tests are reported in **Table 1** as well as the calculated G1 ballistic coefficients for these bullets.

With the exception of one anomalous result for a .40 S&W shot from the Beretta 96, comparable G1 BC values were obtained from polygonal bores and rifled bores further indicating that the polymer coatings had remained intact.

Acknowledgements

Thanks are extended to Michael Haag at the Albuquerque, New Mexico Forensic Science Center for the FTIR spectra of the polymer coating on these bullets, *Nyclad* bullets and his subsequent spectra library search, and to Sergey Perunov for his scanning and preparation of the numerous digital image files of specimens of the *Syntech* bullets, conventional bullets discharged from the same firearm and specimens of the Herter's *TNJ* bullets.

Special thanks and appreciation are extended to Dr. Ludwig Niewöhner at the BKA Laboratory, Wiesbaden, Germany for his analysis of the *Catalyst* primer mixture and the chemistry of bullet wipe produced by these bullets.

References

[1] *Infinity 7,* Exterior Ballistics Software, Sierra Bullets, Sedalia, Missouri, 65301.

[2] (author not stated), "Smith & Wesson Nyclad Bullets are Identifiable", AFTE Journal, Vol. 11, No. 3 (July 1979), pp. 66-69.

[3] Haag, L.C. and L. Niewöhner, "Identifying Bullet Holes and Gunshot Wounds Produced by Tracer Bullets: Elemental Mapping of Bullet Holes", AFTE Journal, Vol. 46, No. 2 (Spring 2014), pp.114-124.

[4] Berk, R. and A. Horn, "Nyclad Ammunition, A Case for Trace?", AFTE Journal, Vol. 49, No. 2 (Spring 2017), pp. 66-68.

(Table 1 continued on next page)

9mm GLOCK 17 – 4.25-in. Barrel

Muzz. Vel. (f/s)	100-yd Vel. (f/s)	G1BC
1191.0	979.2	0.116
1186.0	988.1	0.125
1189.3	986.1	0.123
1179.0	990.7	0.131
1193.2	989.0	0.123
1177.4	981.7	0.123
1186±6		**0.123±0.005**

9mm BERETTA 92FS – 5-in. Barrel

Muzz. Vel. (f/s)	100-yd Vel. (f/s)	G1BC
1175.6	989.5	0.131
1165.6	974.1	0.121
1183.2	963.9	0.132
1169.3	971.3	0.107
1173.3	988.2	0.117
1173.7	989.5	0.131
1173±6		**0.123±0.010**

.40 S&W GLOCK 23 – 4-in. Barrel

Muzz. Vel. (f/s)	100-yd Vel. (f/s)	G1BC
1025.8	928.7	0.169
1036.7	932.9	0.163
1037.3	934.6	0.165
1040.4	936.1	0.164
1037.1	938.7	0.174
1045.5	944.0	0.173
1037±6		**0.168±0.005**

.40 S&W BERETTA 96 – 5-in. Barrel

Muzz. Vel. (f/s)	100-yd Vel. (f/s)	G1BC
1063.0	949.8	0.162
1049.2	940.1	0.163
1040.7	915.3	*0.131**
1064.3	950.9	0.162
1081.9	964.5	0.167
1047.1	943.7	0.170
1058±15		**0.159±0.014**

*If this value is omitted, **G1=0.165±0.003**

.45 AUTO GLOCK 21 – 4.5-in. Barrel

Muzz. Vel. (f/s)	100-yd Vel. (f/s)	G1BC
777	732	0.159
806	755	0.148
801	754	0.160
799	755	0.159
800	753	0.164
797±11		**0.158±0.006**

Note: The average muzzle velocity and BC for 5 shots from the SIG P220 were 768f/s±12f/s and 0.153±0.005.

Table 1: *Infinition* Doppler radar results and G1 ballistic coefficient calculations