

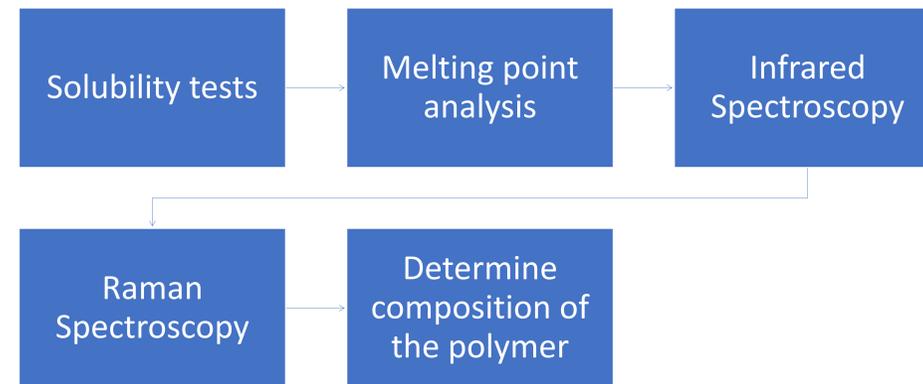
Analysis of Polymer Coated Bullets Using Spectroscopic Methods

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Abstract

Polymer coated bullets have gained popularity in recent years. To determine the composition of two polymer coated bullets [American Eagle Syntech (red polymer) and Syntech Defense 9 mm Luger (blue polymer)], the solubility, melting point and molecular vibrations of the polymers were examined. Our results indicate that the blue and red polymers studied had different solubilities, melting points and molecular vibrations. Infrared spectroscopy revealed that the blue polymer had similar functional groups to dimethyl iso phthalate while the red polymer had similar functional groups to poly(ethylene glycol terephthalate). These results confirm that both polymers have different compositions as evident by the differences in solubility, melting point and their infrared signatures. The next step would be to study various targets shot with polymer coated bullets for the presence of polymer residue. This can be helpful to link evidence from a crime scene to known polymer coated bullets.

Research Approach



Conclusions & Next Steps

- IR spectroscopy revealed that the blue polymer has similar functional groups to dimethyl iso phthalate while the red polymer has similar functional groups to poly(ethylene glycol terephthalate).
- Next, Raman spectroscopy will be used to either further identify the polymer coatings or reinforce the IR results.
- Since these types of polymer coated bullets do not retain individualizing minutiae like standard bullets do, the next steps in our research would be to determine if traces of the polymer can be detected on impact marks, such as the steel plate.

Introduction & Aims

A new line of ammunition released by Federal Ammunition Company employs a synthetic jacket which encases the lead core in a polymer. The synthetic jacket reduces the wear on the bore of the gun as well as prevents metal-on-metal contact between the bullet and the bore. Additionally, polymer coated bullets reduce the friction inside the barrel of the gun.

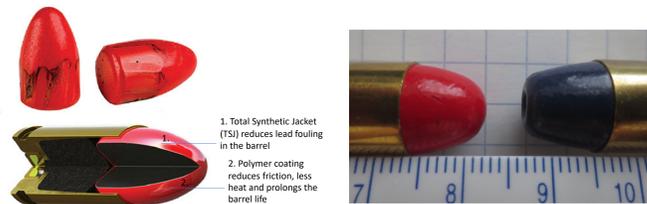


Figure 1. Examples of synthetic jacket used for polymer coated bullets

Hypothesis: Methods such as Infrared spectroscopy and Raman spectroscopy can be used to determine the composition of the polymer coatings. These two methods will provide insight into both the IR active and Raman active bonds present in the polymer coatings.

Aims:

- Determine the composition of the polymer coatings as it can lead to knowing if the polymer contains harmful substances, such as phthalate plasticizers.

Results

Red Polymer	
Soluble	Insoluble
Phenol	Toluene
Methylene Chloride	Ethanol
Acetonitrile	Ethyl Acetate
Ethylene Glycol	Glycerine
Petroleum Ether	Amyl Acetate
1,1,1-Trichloroethane	1-Butanol
Acetone	Dibutyl Phthalate
	Methanol
	Cyclohexane
	Buffer pH 8
	Buffer pH 6
	n-Heptane
	Olive Oil
	Mineral Oil Light
	n-Hexane

Figure 2. Solubility data for the red polymer

Blue Polymer	
Soluble	Insoluble
Toluene	Ethanol
Phenol	Ethyl Acetate
Methylene Chloride	Ethylene Glycol
Acetonitrile	Glycerine
Amyl Acetate	1-Butanol
Petroleum Ether	Dibutyl Phthalate
1,1,1-Trichloroethane	Methanol
Acetone	Cyclohexane
	Buffer pH 8
	Buffer pH 6
	n-Heptane
	Olive Oil
	Mineral Oil Light
	n-Hexane

Figure 3. Solubility data for the blue polymer

Melting Point Data

Blue polymer: 83-86 °C
Red polymer: 373-388 °C

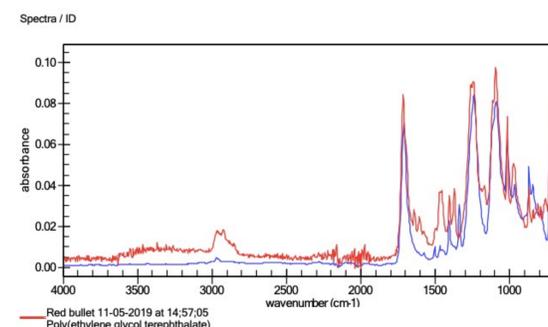


Figure 4. IR spectrum of the red polymer overlaid with top library match

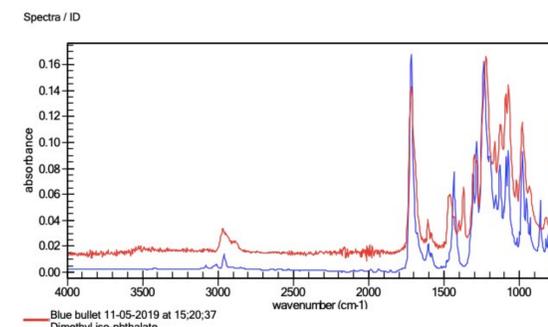


Figure 5. IR spectrum of the blue polymer overlaid with top library match

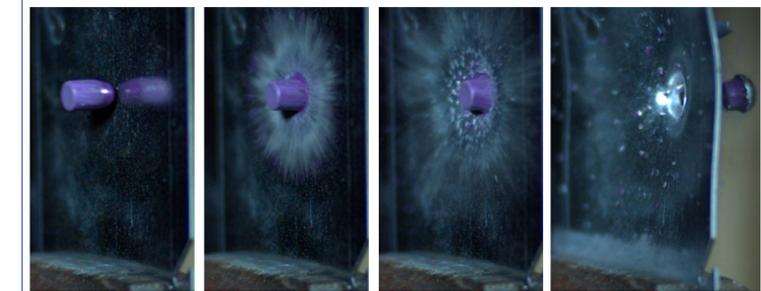


Figure 6. Polymer coated bullet perforating a steel plate and sending traces of the polymer in all directions

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