A polymer replication process has been developed to produce replications of bullets & cartridge casings. These are used to generate large proficiency testing sets and share evidence between jurisdictions where chain-of-custody requirements need to be maintained. NIST is also using the replication process to replenish the SRM 2460 Standard Bullet used for quality control of ballistic imaging.

Polymer replication is a two-step process where: 1) A negative mold of a master bullet or casing is produced by immersing in silicone and allowing to cure, and 2) Positive replica(s) are made from the negative mold using polyurethane.

### Bullet Replication
- A negative mold of the master bullets is produced using a replication container
- Vacuum/degassing is used to remove micro-bubbles from the silicone before curing
- Polyurethane is used to produce positive replicas from the silicone molds
- Pressurization is also used during curing to remove micro-bubbles
- Sputter coating of metals to replica surfaces
- Nickel or Chrome is applied for durability
- Gold is applied for optical properties and non-oxidizing

![Master bullets mounted in replication container](image1)
![Silicone mold and its respective Master bullets](image2)

Topography measurements of the bullet striations are performed and Cross Correlation analysis is performed to quantify the degree of similarity between master and replicated bullet.

![Surface topography map of Breech Face of replica casing](image3)
![ACCF Correlation of master casing to replica](image4)

### Cartridge Case Replication
- A similar process is used for casing replication
- Polyurethane replicas are produced from a silicone mold
- Different replication containers are used
- Back face of casing is replicated where most of the important features reside
- Surface topography measurements of casing surfaces of interest are performed (Breech Face, Firing Pin, Ejector)
- Area Cross Correlation analysis

![Master casing (left) and replica (right)](image5)
![Comparison microscope image of a master casing (left) and replica (right)](image6)
![High mag comparison microscope image of a master casing (left) and replica (right)](image7)

99.05% ACCF

- Production of a large proficiency testing set in collaboration with the Netherlands Forensic Institute (NFI) is currently underway
- 162 casings x 25 molds = 4,050 total replicas to be produced

![Large set of casings for replication](image8)
![Several of the casing molds](image9)
![One set of replica casings](image10)

The polyurethane replicas are metal coated with Nickel, Chrome, or Gold using a sputter coating process. The metal coatings give higher durability and good optical properties for microscopy. NIST has performed testing of the replicated bullets and casings to quantify the degree of similarity of the replicas to the masters they are produced from. The surface topography is measured using surface profiling and non-contact (optical) techniques, and cross-correlation algorithms are used to quantify the similarity.