

# Polymer Replication of Bullets & Cartridge Casings

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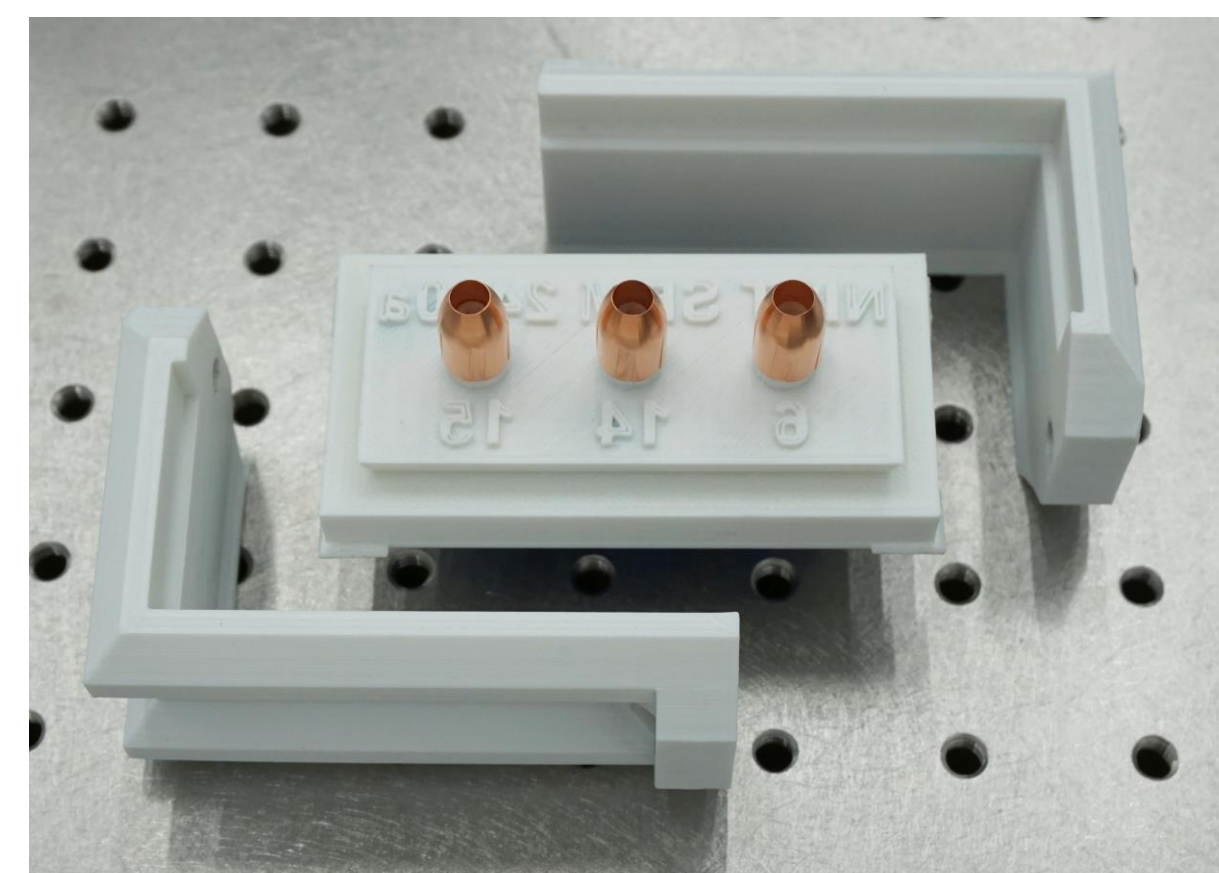
A polymer replication process has been developed to produce replications of bullets & cartridge casings. These are used to generate large proficiency testing sets and share evidence between jurisdictions where chain-of-custody requirements need to be maintained. NIST is also using the replication process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

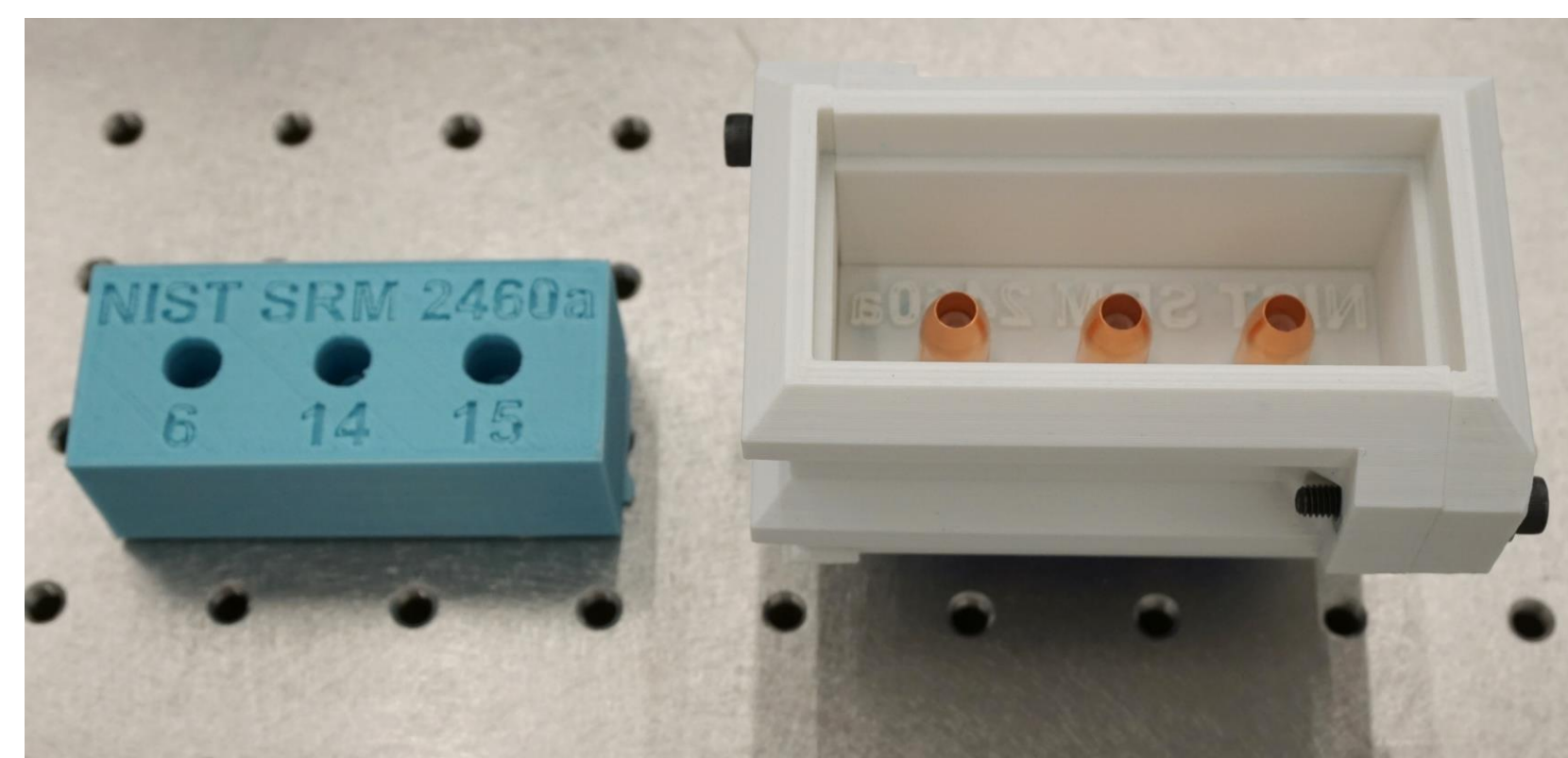
The polyurethane replicas are metal coated with Nickel, Chrome, or Gold using a sputter coating process. The metal coatings give higher durability and good optical properties for microscopy. NIST has performed testing of the replicated bullets and casings to quantify the degree of similarity of the replicas 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.

- 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

## Bullet Replication



Master bullets mounted in replication container

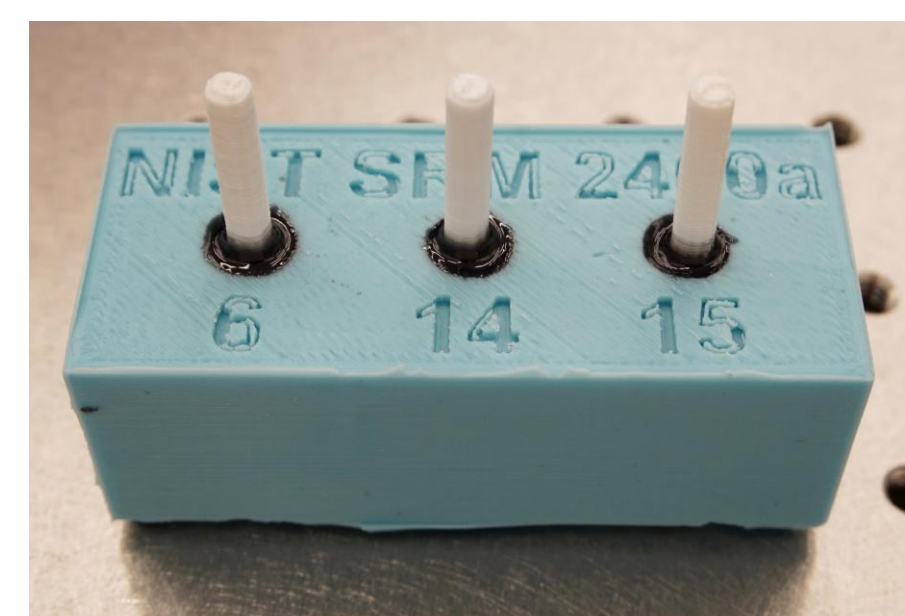


Silicone mold and its respective Master bullets



Standard Bullet – SRM 2460-038

- Polyurethane is used to produce positive replicas from the silicone molds
- Pressurization is also used during curing to remove micro-bubbles



Replicas ready to be removed from mold

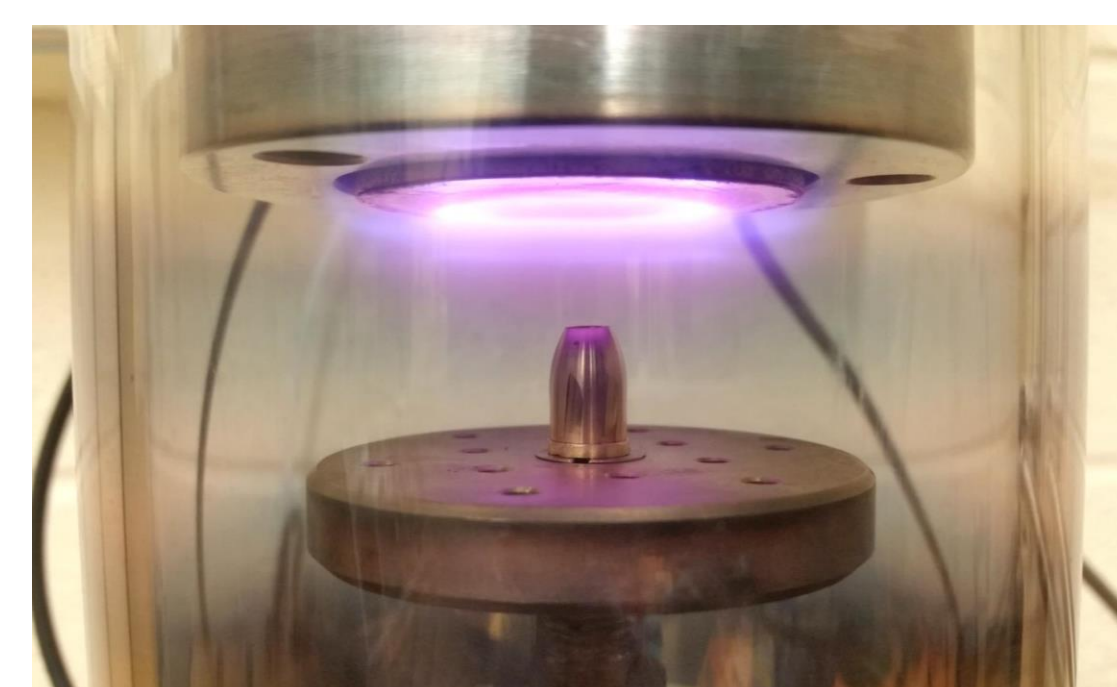


Polyurethane replica with removal stub



Polyurethane bullet replica

- Sputter coating of metals to replica surfaces
- Nickel or Chrome is applied for durability
- Gold is applied for optical properties and non-oxidizing

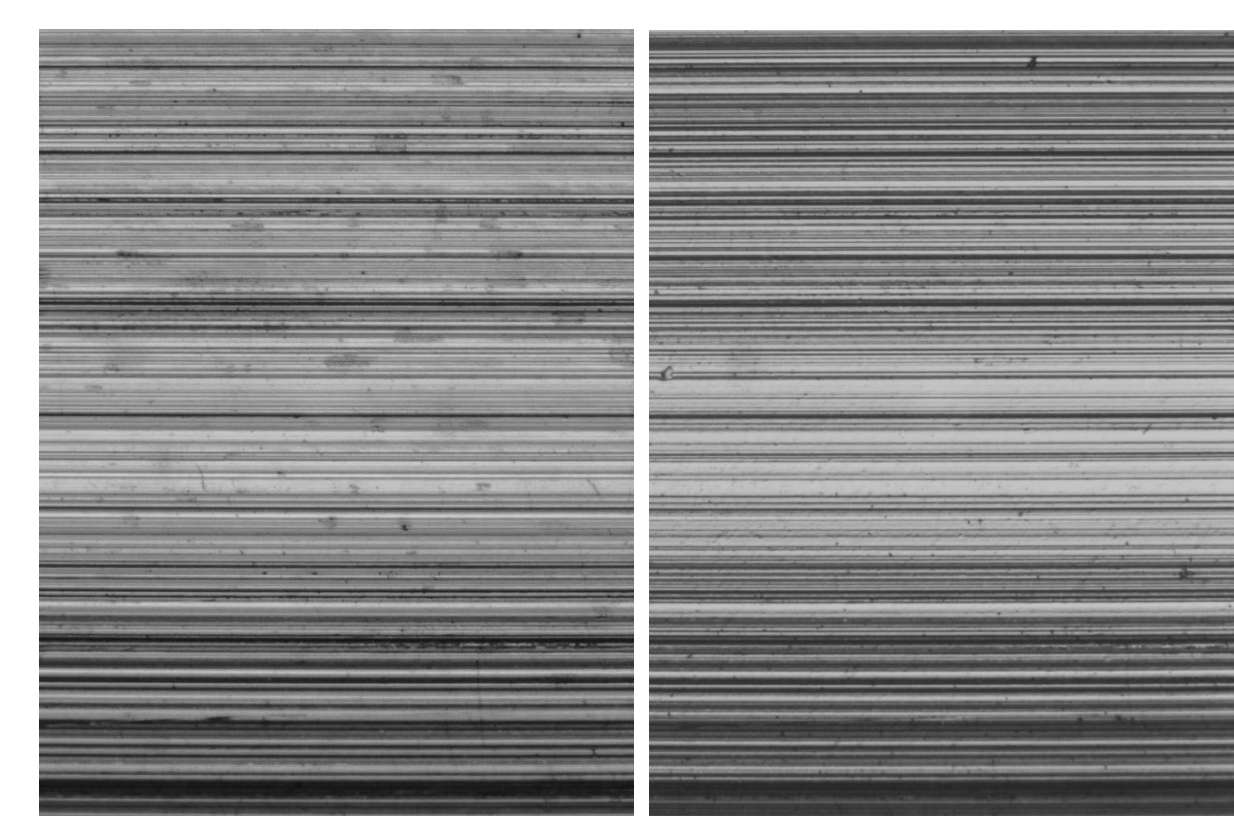


Sputter coating a bullet replica

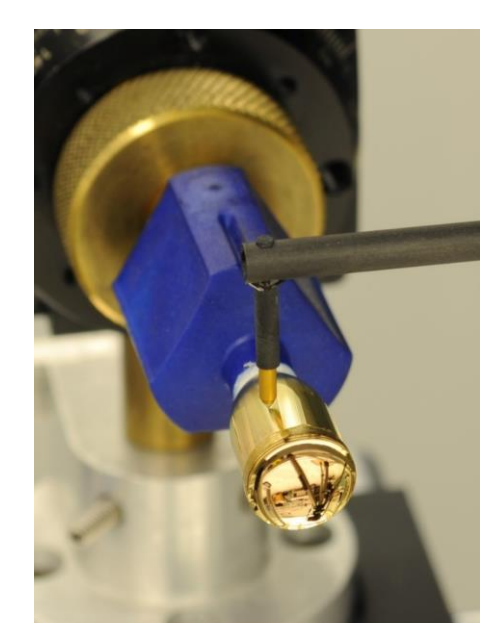


Gold coated replica on a sample holder

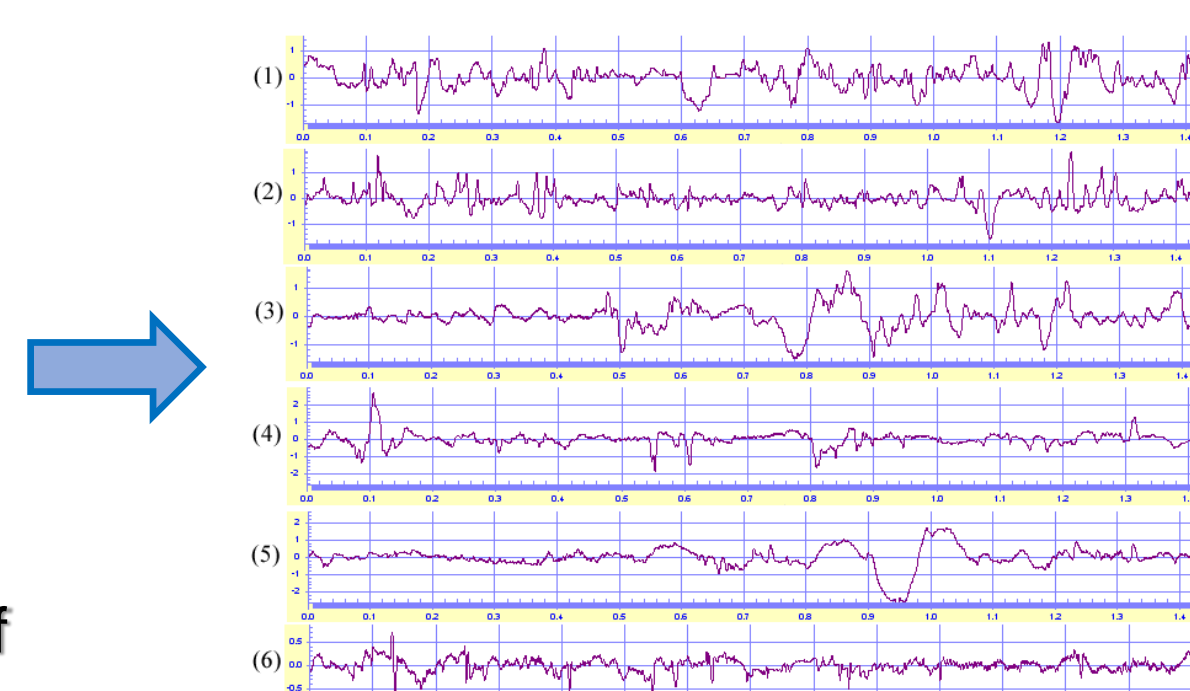
Topography measurements of the bullet striations are performed and Cross Correlation analysis is performed to quantify the degree of similarity between master and replicated bullet



Optical comparison of the same land impression from a master bullet (left) and the polyurethane replica (right)



Stylus profiling measurement of bullet replica



Surface profiles from 6 lands

99.37% CCF



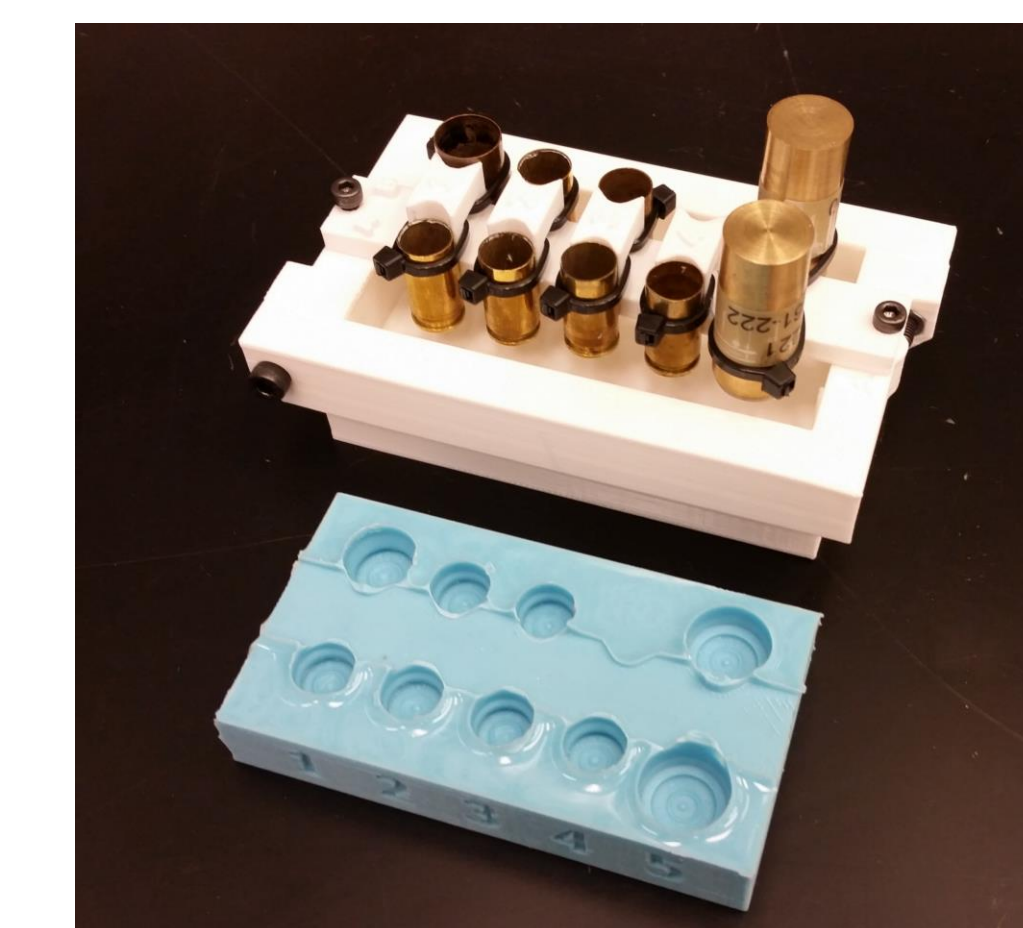
CCF Correlation analysis program

## 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



Casings mounted in replication container



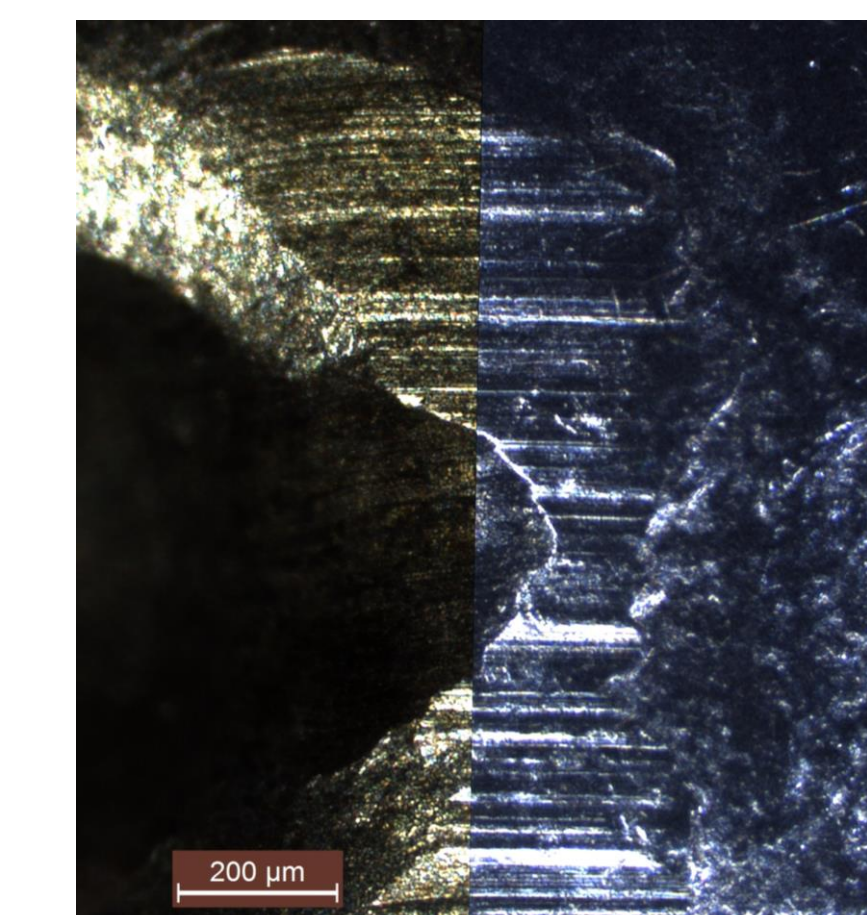
Silicone mold and respective casings



Master casing (left) and replica (right)



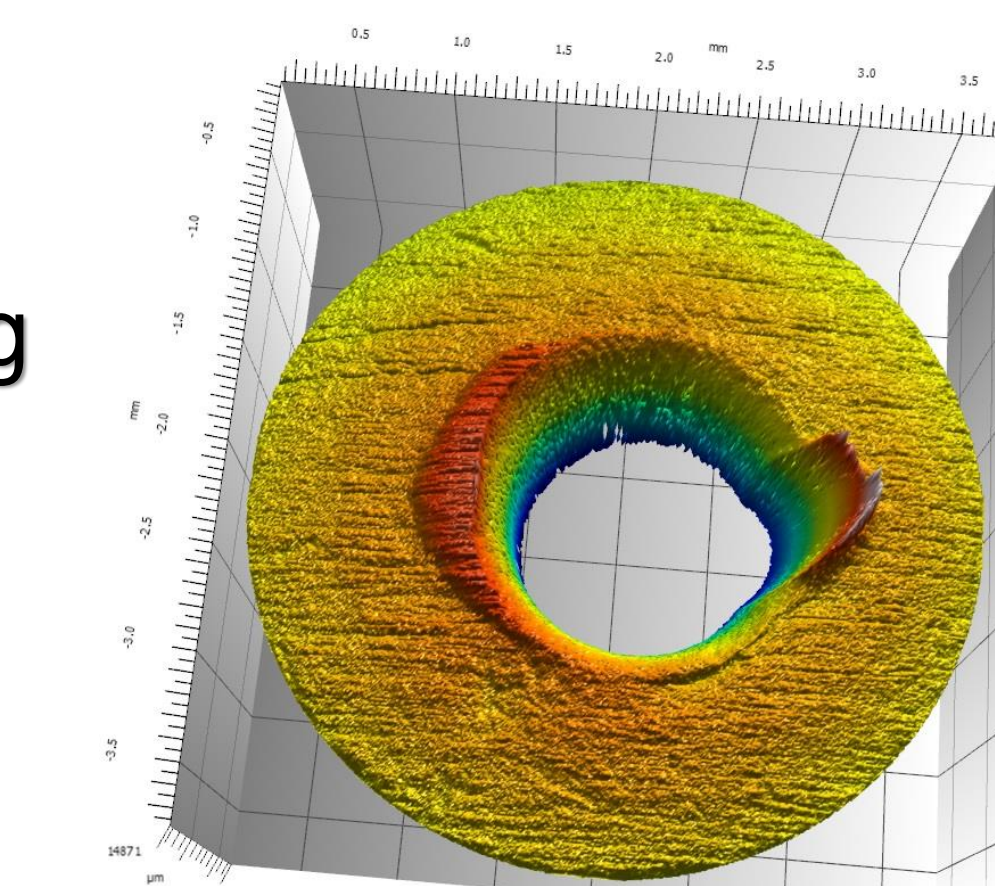
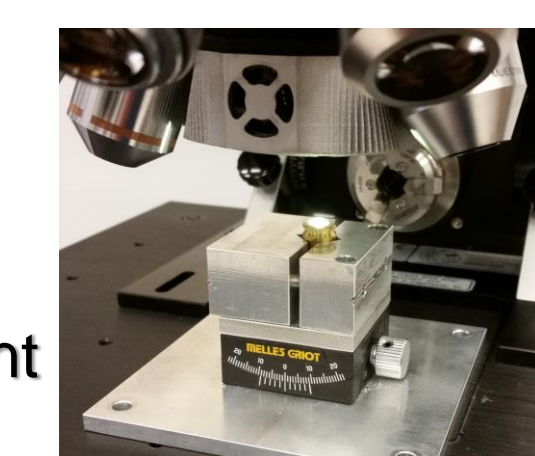
Comparison microscope image of a master casing (left) and replica (right)



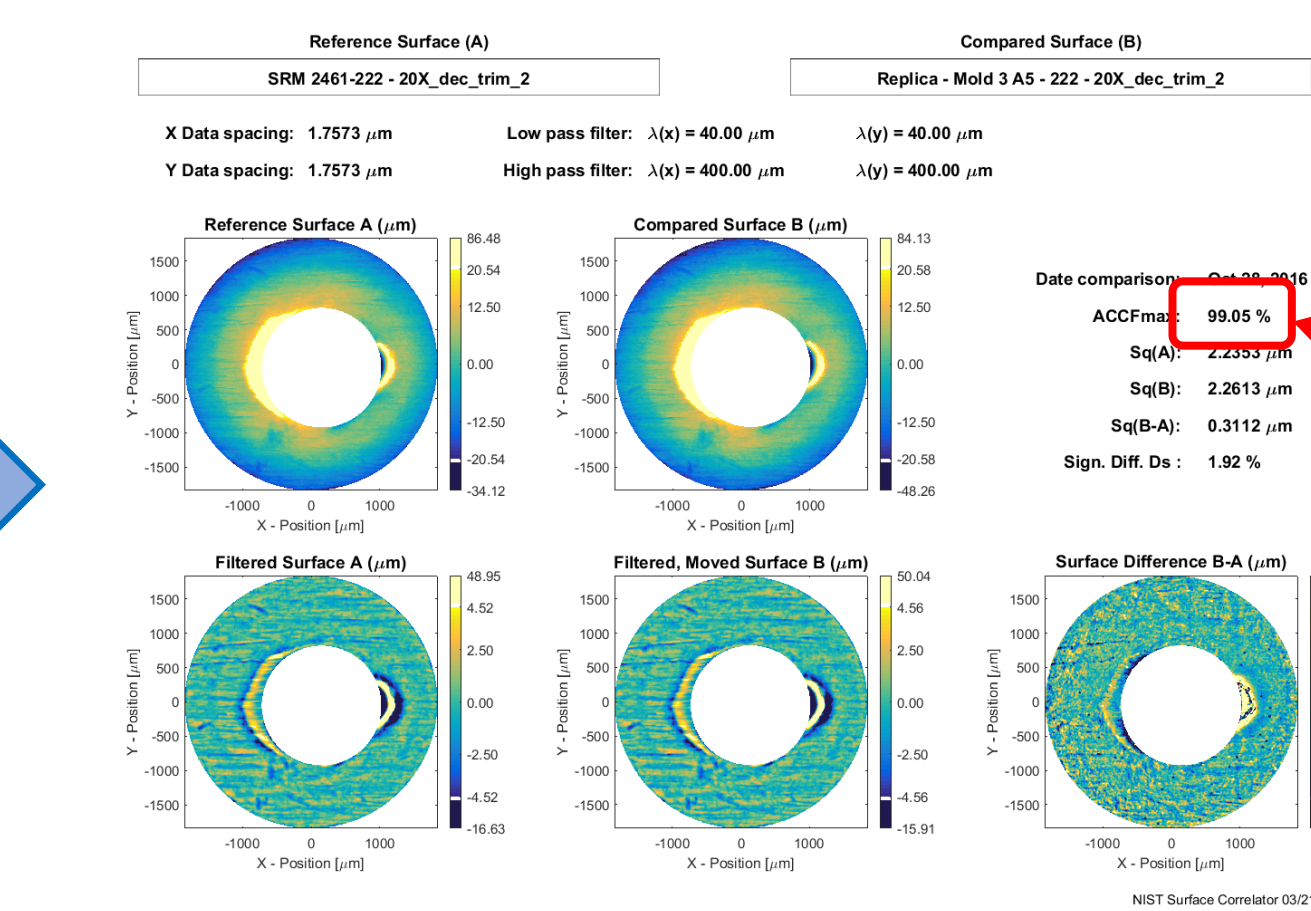
High mag comparison microscope image of a master casing (left) and replica (right)

- Surface topography measurements of casing surfaces of interest are performed (Breech Face, Firing Pin, Ejector)
- Area Cross Correlation analysis

Measurement of casing



Surface topography map of Breech Face of replica casing



ACCF Correlation of master casing to replica

99.05% ACCF

- Production of a large proficiency testing set in collaboration with the Netherlands Forensic Institute (NFI) is currently underway



Large set of casings for replication



Several of the casing molds



One set of replica casings

- 162 casings x 25 molds = 4,050 total replicas to be produced