MEMS Safety and Arming Device Manufacturing

PROBLEM / OBJECTIVE

Micro Electro-mechanical Systems based Safety and Arming (MEMS S&A) devices fabricated using the X-ray LIGA process (German acronym: i.e., deep X-ray lithography, electroforming, and molding) have been demonstrated to survive the Army's harsh gun-launch environment under earlier S&T efforts. The devices could not be produced in large quantities at an affordable cost. X-ray LIGA fabrication is expensive for production because of the reliance on Synchrotron-based radiation (few synchrotrons in the USA). In addition, conventional explosives were too large for MEMS S&A use. New formulations and batch deposition of micro explosives were needed.

ACCOMPLISHMENTS / PAYOFF

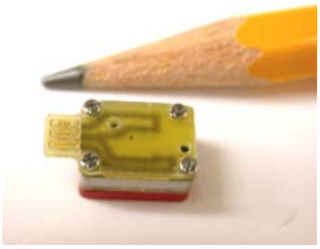
Process Improvement: The goals of the ManTech effort were to determine a MEMS S&A fabrication process, investigate an explosive loading technology and to develop an assembly method.

A low-cost Ultra Violet (UV) LIGA process is now being utilized to fabricate the high aspect ratio parts and frames required for the S&A. This non-Silicon fabrication approach provides smooth sidewall parts with no stiction issues. Design improvements that minimize the number of components have been completed. The newest configuration of the MEMS S&A will have the same form factor for either large-caliber gun launched munitions or med-caliber high-explosive air-burst munitions.

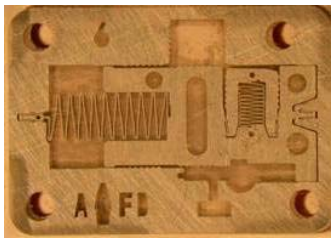
Adopting MEMS technology for fuzing applications required a move away from traditional explosive loading techniques (e.g. pelletized charges) and towards scaleable loading techniques (i.e. explosive slurry at the wafer level, direct write loading). Explosive formulations have been developed and direct write dispensing has been demonstrated.

Ballistic testing in XM25 25 mm Integrated Airburst Weapon was conducted and incorporated an improved initiation board. The MK19 40 mm Grenade Machine Gun is being used to validate additional manufacturing design changes such as sintered powdered frames, secondary explosive formulations and packaging solutions.

S&A automated assembly demonstrated vision recognition, kitting (nesting from random parts), component inspection and precision placement. A lean six-sigma project was initiated to determine a packaging solution. Both automated screws and welding solutions have been investigated for long-term, high volume use.



MEMS S&A



MEMS Layer

Implementation and Technology Transfer:

The MEMS S&A ATO-M supported the Fuze and Power Army Technology Objective (FAP ATO) in providing prototype MEMS fabrication for artillery applications. The FAP ATO demonstrated a command arm MEMS S&A as a potential drop-in S&A replacement for use in Precision Guided Kit Increment 2. Requirement for that program have changed necessitating an application change in MEMS application. The MEMS S&A has now transitioned to an EMD project ending in FY12, managed by PM Soldier Weapons, to the MK19 40 mm M430 HEPD application. The goal of the project is to improve munition performance against soft targets and reduce arming time variability.

Expected Benefits:

MEMS is an enabling technology that will lead to increased fuze functionality for smart munitions. More and more projects require new capabilities such as airburst, GPS navigation and course correcting. These new features all require increased volume afforded by implementation of MEMS fuzing.

TIME LINE / MILESTONE

Start Date: FY 04
End Date: FY 07

FUNDING

Army ManTech: $12.5M

PARTICIPANTS

Army / RDECOM-ARDEC
Alliant Techsystems Plymouth, MN