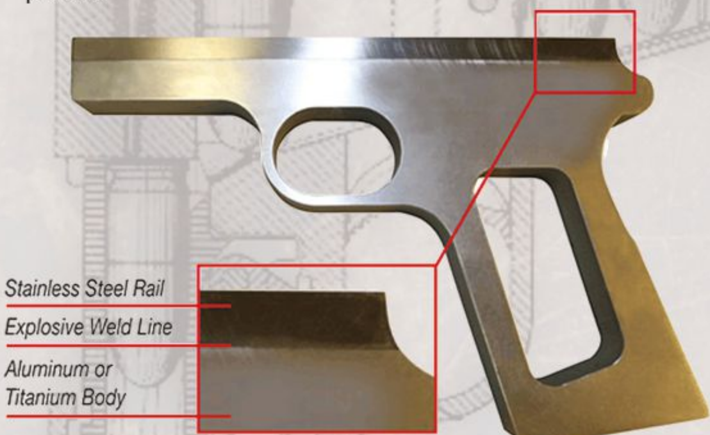
EXPLOSIVE BONDING IN FIREARMS MANUFACTURING

By Jessica Buck & David Buck

Military EOD technicians and public safety bomb technicians and investigators are familiar with many different ways explosives are used: in ordnance, demolition, IEDs, IED defeat, mining, and road construction, among others. What may not be so well-known are their applications in manufacturing. The Detonator ran an interesting article several years ago describing the use of sheet explosives in train rail hardening [1]. What follows is an introduction to another way in which explosives are used in the manufacturing process, the making of custom 1911 pistols.

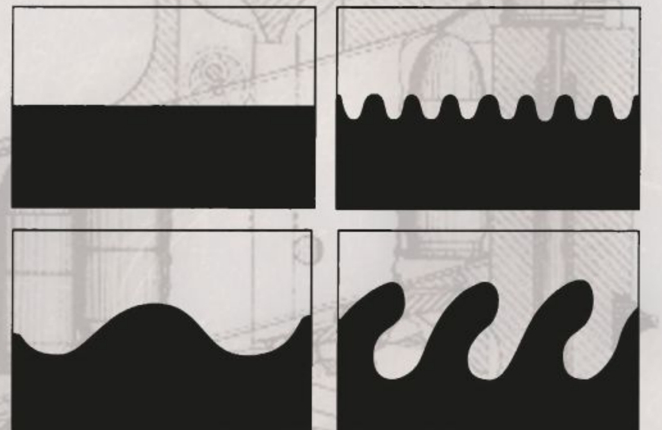


Three types of materials that are most often machined into firearms components are carbon steels, stainless steels, and aluminum alloys. There are benefits and drawbacks to each of these metals. The steels have very high yield strengths and are ductile enough to withstand large stresses without failing. But they are also relatively heavy. Conversely, aluminum is lighter than steel, but does not have comparable strength or hardness. Aluminum frame rails, for example, would not last long on a semi-automatic pistol. One has to choose between the durability of steel and the weight advantages of aluminum or titanium. At least that used to be the case.

With a process called “explosive bonding,” or “explosive welding,” it is now possible to have both a durable and a lightweight pistol. One firearms manufacturer is currently using this welding technique to bond high strength steel to the frames, slides, and feed ramps of their lightweight aluminum-framed or titanium-framed 1911 pistols. This illustrates the point that "there are very few problems which cannot be solved by the suitable application of high explosives."

What is "explosive bonding?"

Explosive bonding is the use of explosives to create the tremendous forces necessary to seamlessly bond two dissimilar metals. The microscopic interface between the two materials (stainless steel and aluminum in the case of the 1911’s) often resembles that of a sine wave. The amplitude and frequency of this wave can be controlled by the explosive load, the detonation velocity, and the interface spacing between the metals at the time of the blast [2]. Different wave frequencies and amplitudes allow for different maximum interfacial shear strengths to be reached, and therefore provide a significant advantage over other welding techniques.



Depictions of microscopic explosive weld lines created by various types of detonations.

About the authors:
Jessica Buck is a Mechanical Engineering student at Michigan Technological University, expecting to graduate in May 2015. She is currently the project manager for Movalson Consulting Services, Inc. Spl/Sgt. David Buck has been working as a certified Bomb Technician with the Michigan State Police since 2003.

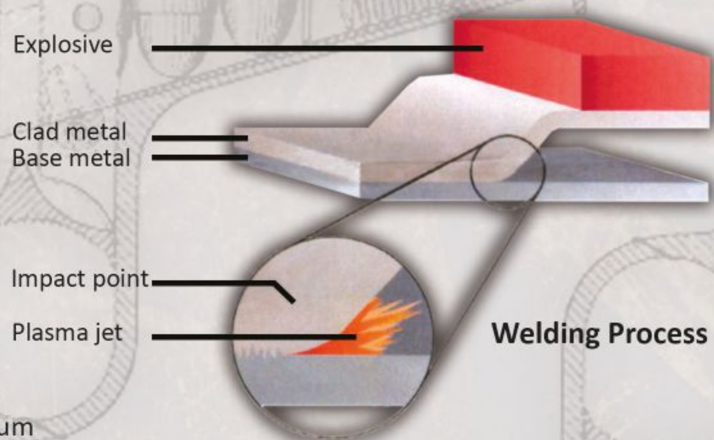
Explosive bonding doesn't affect the original properties of the two metals like other welding methods do, and also has no resulting heat-affected zone (HAZ). A HAZ is often the place where parts fail due to their reduced yield and fracture strengths. HAZ-free welding is therefore a major advancement in manufacturing technology.

Explosive bonding is relatively new to firearms manufacturing. Tennessee-based DBA UA Arms, Inc. became the first company to take advantage of this revolutionary welding technique in gun making several years ago. CEO Rick Uselton, a Vietnam veteran and retired Sumner County (TN) Sheriff's auxiliary deputy, received a call from Lew Wear of Washington-based Souriau Pacific Aerospace & Electronics (PA & E) and the two began to collaborate. UA Arms now contracts with PA & E to explosively bond the aluminum and steel blocks which are later machined into pistol frames, slides, and feed ramps. PA & E employs explosives engineers who have developed and refined this process. They have received one patent in the application of explosive bonding in firearms manufacturing and another is pending. The end result is that UA Arms' composite frames achieve a 40-60% weight reduction compared to steel frames, without compromising durability. Other firearms manufacturers are now considering this technology as well.

How does the process work?

Wear, the retired president and CEO of PA & E and now a consultant for the company, described the basic range process as follows: a 5" block of aluminum measuring approximately 12" x 24" and a ½" block of steel of the same dimensions are placed upright and back to back, separated by a 1/8" air gap. Wooden frames each containing about 35 lbs. of ANFO are placed on either side of the metal blocks in a vertical "ear muff" type configuration. Each charge is initiated by a cast booster primed with det cord. A non-electric blasting cap, shock tube, and a 209 primer complete the firing train.

Setting up these charges is a very labor-intensive and time-consuming process, but when it is done well the newly bonded block does not move or deform significantly, due to the net cancellation of forces acting on it. After examination and testing, the blocks are sent to UA Arms to be machined into durable, lightweight pistol frames, slides, and feed ramps.



Explosive bonding has been used for several decades for a range of purposes. It is currently used to make heat exchangers in nuclear reactors, and to provide a transition point between two dissimilar materials in construction, including shipbuilding and train rail manufacturing [2]. The limit of explosive bonding is that the geometry has to be simple. Sheets, blocks, and tubing are basic enough, but more complex shapes cannot yet be explosively bonded.

Explosive bonding applied to the manufacture of pistols makes it possible to create a lightweight, durable, and very intriguing firearm.

References:

[1] *"Explosive Rail Hardening,"* The Detonator, Volume 33, Number 6 (Nov.-Dec. 2006), by G. Michael Grimes, p. 38

[2] *EXPLOSIVE WELDING*. (n.d.). Explosive Metal Welding: Bonding Dissimiliar Metals. Retrieved July 5, 2014, from http://www.pacaero.com/products/explosive-welding-metals.htm

Stone, J. Applications of Explosion-bonded Clads. http://www.dynamicmaterials.com/jdownloads/White%20Papers/applications_of_exw_stone_1968ocr.pdf

Special Ops News. (n.d.). Special Ops News. Retrieved July 5, 2014, from http://www.useltonarms.com/Special_Ops_News/

"Explosive Bonding: The Future of Firearms?," The American Rifleman, May 2012, by Aaron Carter, pp. 40ff