EXPLOSION WELDING
DEFINITION

Explosion welding is a solid-state process that produces a high velocity interaction of dissimilar metals by a controlled detonation.
ADVANTAGES

- No heat-affected zone (HAZ)
- Only minor melting
- Material melting temperatures and coefficients of thermal expansion differences do not affect the final product
- The shock front compresses and heats the explosive material which exceeds the sonic velocity of undetonated explosives
COMPONENTS TERMINOLOGY

- Base component
- Cladding metal
- Flyer plate
- Interlayer
- Anvil
- Standoff
- Bond Window
- Bonding Operation
Process

Explosion Clad Plate Manufacturing

1. Plain Material Inspection
2. Grind Mating Surfaces
3. Assembly: Backer, Cladder, Explosive
4. Explosion
5. Flattening and Cutting
6. Testing and Inspection
   - Ultrasonic Examination of Bond, Mechanical Tests, Physical Measurement, Certifications
PROCESS
PROCESS
Fig. 3 — The characteristic wavy explosive weld appearance is clearly visible in this cross section.
EXPLOSIVE MATERIAL

- **High velocity (14750-25000 ft/s)**
  - Trinitrotoluene (TNT)
  - Cyclotrimethylenetrinitramine (RDX)
  - Pentaerythritol Tetranitrate (PETN)

- **Mid-low velocity (4900-14750 ft/s)**
  - Ammonium nitrate
  - Ammonium perchlorate
  - Amatol
DETONATION TYPES

- Shock wave develops if sonic velocity is greater than 120% of material sonic velocity (type 1)
- Detached shock wave results when detonation velocity is between 100% and 120% of material sonic velocity (type 2)
- No shock wave is produced if detonation velocity is less than material sonic velocity (type 3)
WELDING PARAMETERS

- Detonation velocity is a function of:
  - Explosive type
  - Composition of explosive
  - Thickness of explosive layer
## APPLICATIONS

Typical metal combinations that can be explosion welded

Source: AWS handbook
APPLICATIONS

- Can weld large areas of metal
- Can weld inside and outside surfaces of pipes
- Transition joints can be made
APPLICATIONS

- Chemical Processing
- Petroleum Refining
- Hydrometallurgy
- Aluminum Smelting
- Shipbuilding
- Electrochemical
- Oil & Gas

- Power Generation
- Cryogenic Processing
- Pulp & Paper
- Air conditioning & Chillers
- Metal Production
APPLICATIONS

Finished vessel fabricated from explosion clad plate.
APPLICATION
APPLICATIONS

The details of the welding process are shown in the Figure above, where the jet is shown, the welded interface has a wavy pattern.

Figure 7, Explosive welding in tubular geometries.
APPLICATIONS

3” Diameter Al/SS Ring

Copper/Stainless 12” UHV Assembly
Arnold Holtzman and a team at DuPont in Delaware put a lot of research into developing the process.

Holtzman filed for a US patent in 1962 for explosion welding, received the patent in 1964 and began commercial production of bi-metallic explosion welded clad in 1965.

Detaclad licensed the process and was bought by Dynamic Materials Corporation (DMC).

Other companies have merged with DMC and acquired the current name DMC Groupe SNPE making them a worldwide company.
References

- Keith Powell, Michael Fernandez, Staton Burrell, “Explosion Welding” the slide, University of South Carolina
- Ulrich Kruger, “Talat Lecture 4400”, TALAT.
- Henry Tan, “Explosive Welding ”.