

Pacific Aerospace & Electronics

Explosive Metal Bonding Capabilities

PA&E Bonded Metals Division:



2249 Diamond Point Road
Sequim Washington



Who we are:

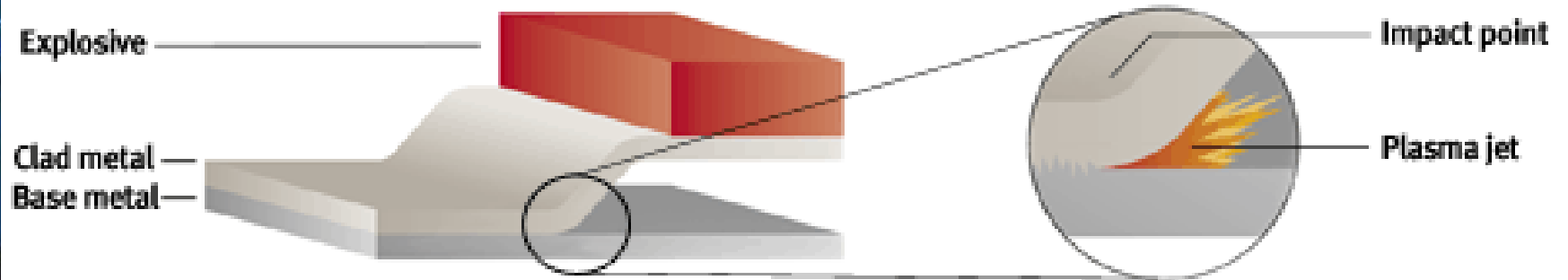
PA&E Bonded Metals Division

- In operation since 1970
- Formally known as Northwest Technical Industries
- Part of PA&E since 1995

What we do:

We use explosives to weld or bond dissimilar metals together and to explosively form metals into exotic shapes that are difficult or impossible to do by conventional methods. Explosives are also used to compact or consolidate metal powders into near net shapes.

The Explosive Bonding Process



Why Explosion Bonded?

- Perfect for meeting both heavy weight and light weight design requirements
- Much stronger than friction and diffusion welded joints
- Location of bond layers can be controlled within a design
- Weldable bi-metallic transitions (ferrous to non-ferrous)
- Eliminates galvanic corrosion (between dissimilar metals)
- Reduced need for mechanical integration (bolt-on vs. welding)
- Precious metal conservation (linings, facings, etc.)
- Markets for this technology include:
 - Chemical industries (corrosion resistance)
 - Power plants
 - Naval applications
 - Particle accelerators
 - Semiconductor production (sputter targets)
 - Space satellites

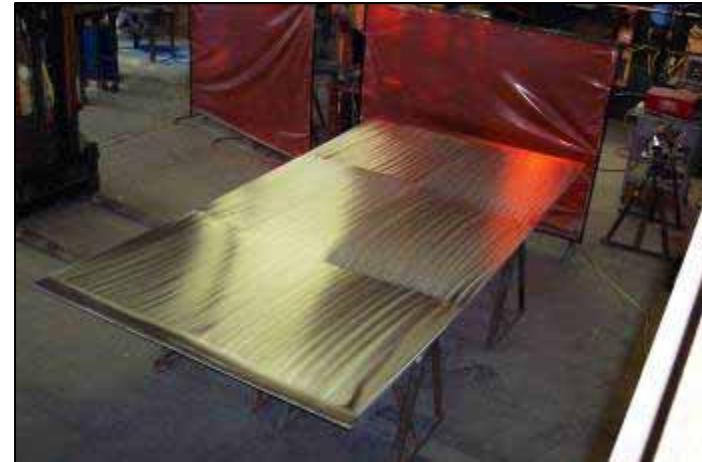
Creating Explosively Bonded Metals

Step 1: Metal Preparation

Here, copper and nickel sheets are surface prepped:



Copper Plate



Nickel Plate

Creating Explosively Bonded Metals

Step 2: Metal Preparation

PA&E employees apply shot assembly to bond Inconel to nickel



Creating Explosively Bonded Metals

Step 3: Transporting Material to Remote Blast Site

Noise created by blasts require material to be transported to a remote area for detonation



Creating Explosively Bonded Metals

Step 4: Preparing for Detonation



Final shot readied for detonation



Hoppers for pouring explosives into charge gap

Creating Explosively Bonded Metals

Step 5: Detonation



Creating Explosively Bonded Metals

Step 6: Flattening



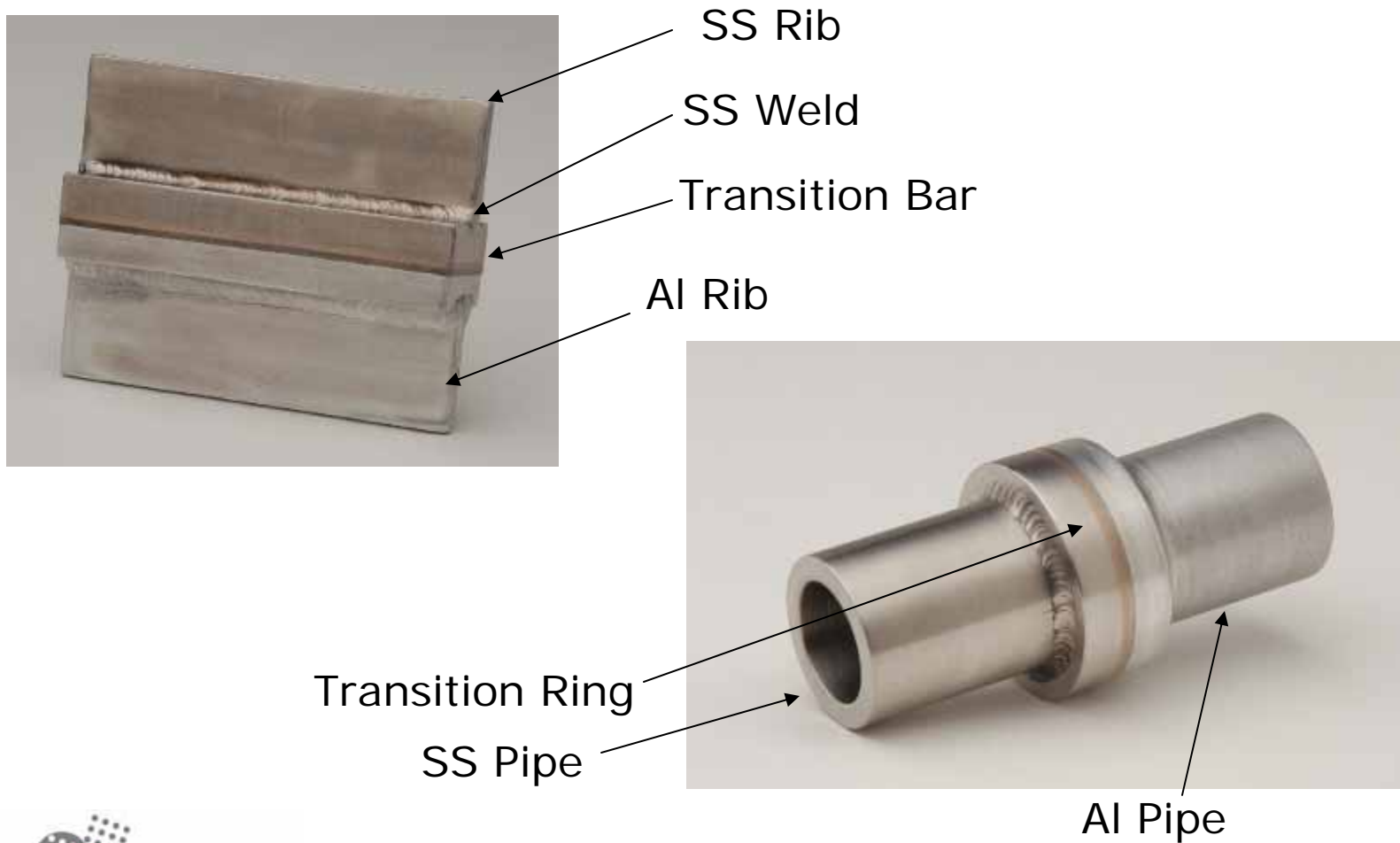
Ni/Inconel plates before flattening



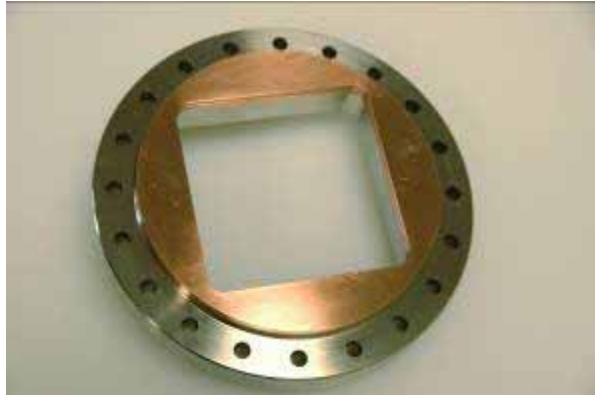
Plates after flattening

Explosive Bonded Metals Examples

Aluminum/Stainless



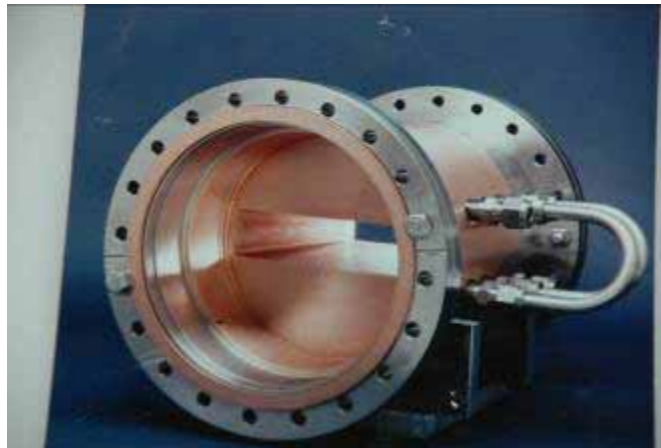
Explosive Bonded Metals Examples



Copper/stainless
UHV conflat flange



Custom 6" conflat
flange with
stainless/copper/stainless



Cu/stainless exit slit for UHV beam line

Explosive Bonded Metals Examples

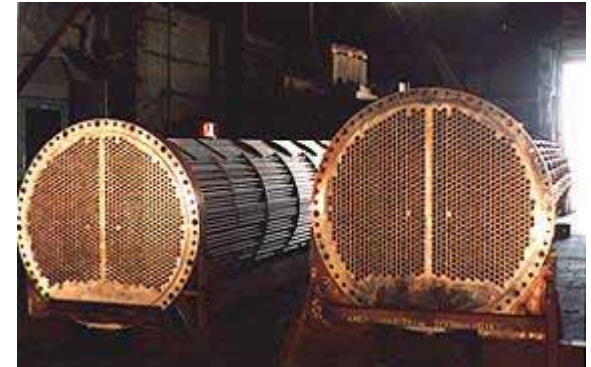
Alum Tube / Steel Billet



Copper / Stainless

Explosive Bonded Metals Examples

SA 240 2507 SS / SA 516 Grd 70 steel to be machined into a tube sheet in heat exchanger



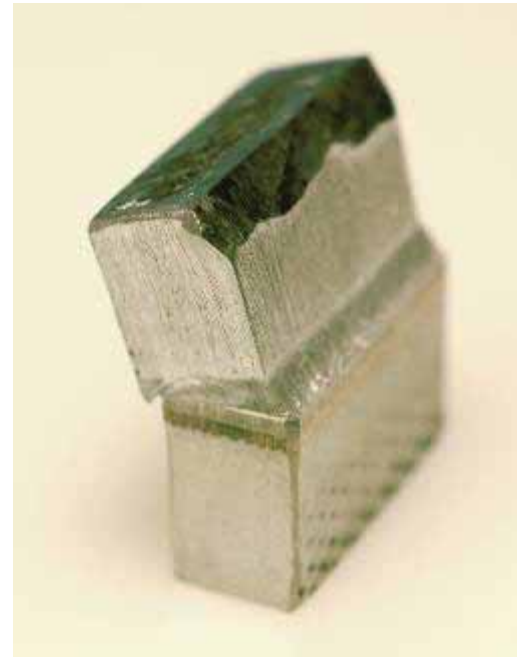
Copper/aluminum

Testing the Bond

Quality Assurance includes bend testing, chisel testing, shear lug testing, ram tensile testing, die penetrate testing, ultrasonic testing and mag. partial testing



Copper/aluminum bend test



Aluminum/stainless steel
hammer test



Tensile test

Testing the Bond

Quality Assurance includes bend testing, chisel testing, shear lug testing, ram tensile testing, die penetrate testing, ultrasonic testing and mag. partial testing.



Shear lug testing



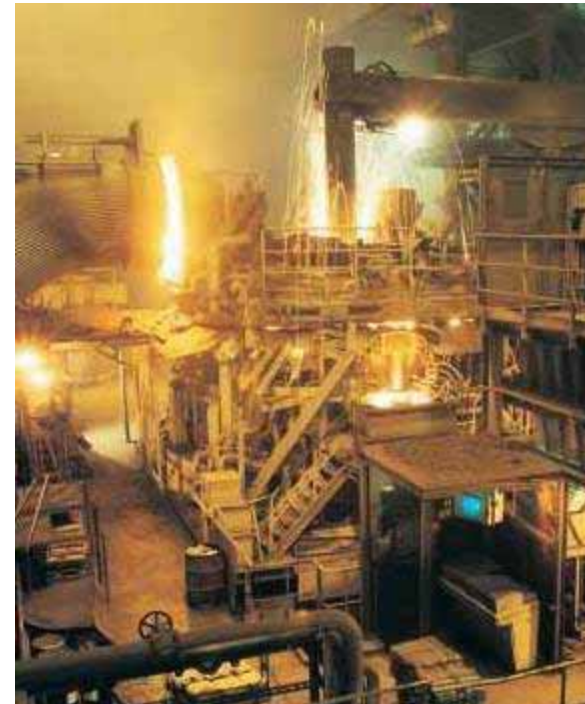
Ram tensile testing

Bonded Metal Applications

Current conducting arms made from copper/steel clad



**Current conducting arms (CCA)
for Electric Arc Furnaces (EAF)**



**Electric Arc Furnace
recycling scrap metal**

Bonded Metal Applications

Clad Tubes



Copper/stainless



Aluminum/steel



70/30 Cu-Ni/steel



Tantalum on I.D. of steel pipe

Bonded Metal Applications

Naval Applications



Alum tube/
steel billet



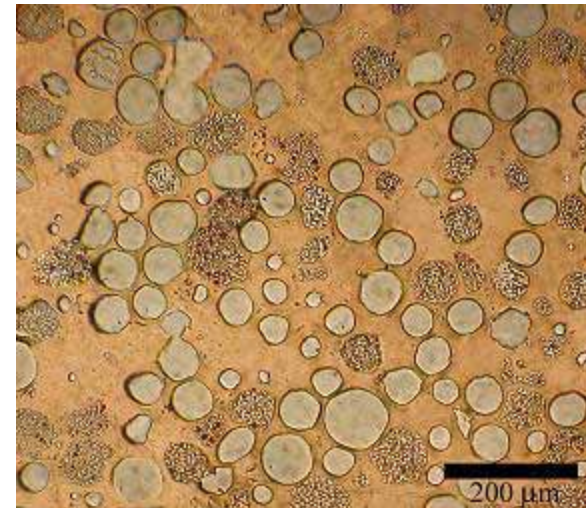
Deployed on US Navy aircraft carriers

Fabricated into
high-strength,
corrosion-resistant
aircraft tie-downs



Bonded Metal Applications

Copper / Moly Explosive Powder Compaction





Learn More!

Contact PA&E's Bonded Metal Division via:

- E-mail at bondedmetals@pacaero.com
- Phone at: 360-683-4167

Or Visit:

- <http://www.pacaero.com/products/explosive-bonding.htm>