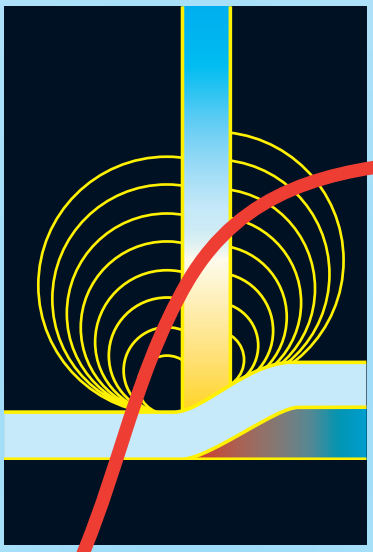
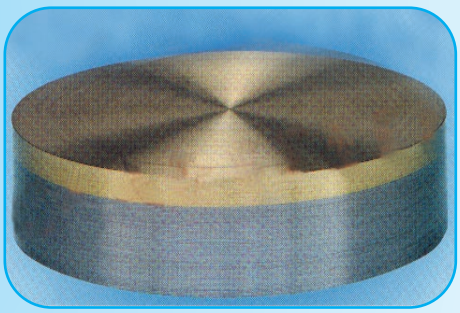
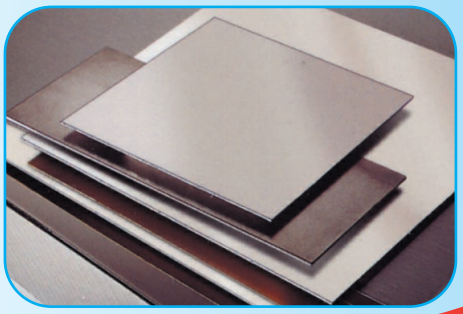
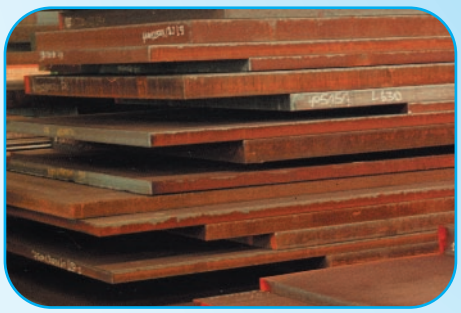
Shockwave Metalworking Technologies (SMT)

Explosion Cladding by Vacuum Technology





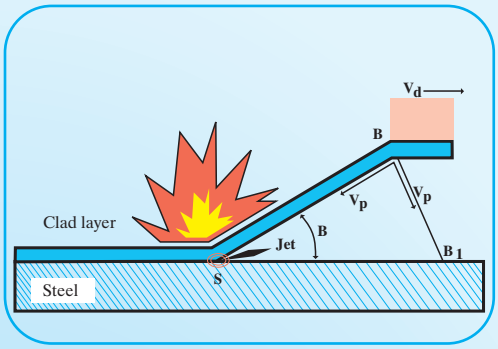




Whatever it is:
Small or Large, Thin or Thick, Standard or Exotic, Rain or Sunshine
We will Clad it for you

Innovations & Efficiency are our Secret

Preface



Explosive cladding is also known as explosion welding. It is the bonding of two or more dissimilar metals with the aid of explosives.
It is accomplished by a high-velocity oblique impact between two metals.
The impact produces sufficient energy to cause the colliding metal surfaces to flow hydro dynamically when they intimately contact one another in order to promote solid-state bonding. The metal surfaces are compressed together under high pressure from the explosion, and an atomistic bonding between the dissimilar metals will be accomplished.
Explosive cladding is a cold 'pressure weld process (at room temperature)'. It is a method to weld metals that cannot be welded by conventional processes, such as titanium-steel, aluminium-steel and aluminium-copper. It can also be used to weld compatible metals, such as stainless steels and nickel alloys to steel.

The cladding metals are typically stainless steel, duplex steel, titanium, aluminium, copper, copper alloys, nickel, nickel alloys, tantalum, and zirconium.
The base metals are typically carbon steel, stainless steel, alloy steel, copper and aluminium.

Explosion-welded clad metals are used in a wide range of industries like: oil and gas, chemical and petrochemical, desalination plants, steel mills & hydrometallurgy, aluminium smelters, shipbuilding, power generation, and other industries where corrosion, temperature and pressure are important parameters.

Main Cladmaterial Applications:

1. Corrosion Resistance layer
2. Aluminium / Steel - Transition Joint: **Triplate®**
3. Electrical Transition Joint (Anode - Cathode blocks)

Introduction

Shockwave Metalworking Technologies BV (SMT) was established in 1962 and involved in explosive cladding for more than 40 years.
In 1985 a vacuum chamber for explosive cladding was developed.
At the moment 3 chambers are in use for the production of different type of clad plates. The largest chamber we developed is 15 meter long and almost 7 meter in diameter.
SMT is an innovative and flexible company.
We offer a wide range of clad plates at competitive prices and within a very reasonable delivery time.
Because of our unique vacuum explosion technique, we can handle all type of material combinations and projects of different sizes. This technique is designed to protect the environment and to serve our clients.

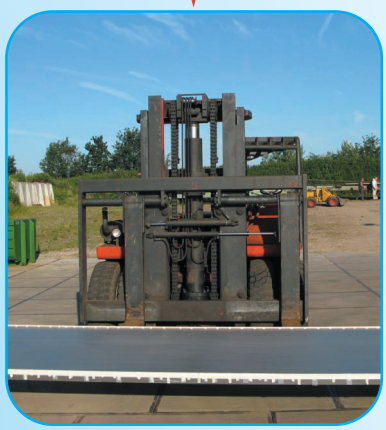
Grinding

Preparing Set-up

Set-up

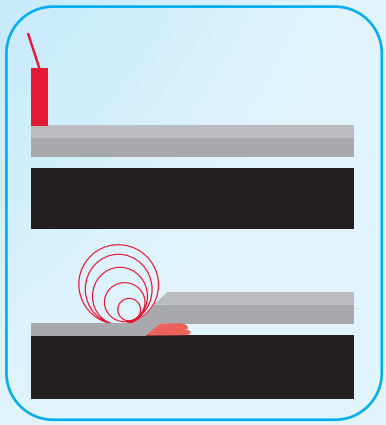
Fabrication Process

The cladding process is started with the preparation (Grinding and Cleaning) of the surface of both base material and clad material.
The clad material is placed on top of the base material and between the two materials we place spacers to keep an appropriate 'stand-off'.
The assembly of the materials is accomplished in accordance with the clad set-up parameters (stand-off gap, quantity of explosives, surface protection, ignition point).
The clad assembly will be put in the vacuum chamber, on top of a prepared sand bed.
The powder explosives will be applied on the clad surface together with the booster charge.
After placing the electrical detonator, the vacuum chamber will be closed and the evacuation of the air will start.
When the under pressure reach the required value, the detonation of the explosive charge will take place by ignition the detonator at the control room.
The cladded plates will be further prepared for finishing: Visual check, flattening, US examination, DT/NDT and packed for transport.



Transport to vacuum chamber

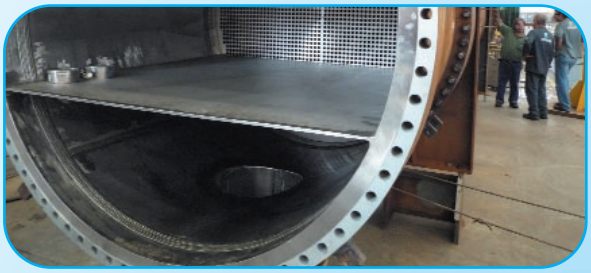
Evacuating vacuum chamber



Explosion Cladding

Flattening

Transportation



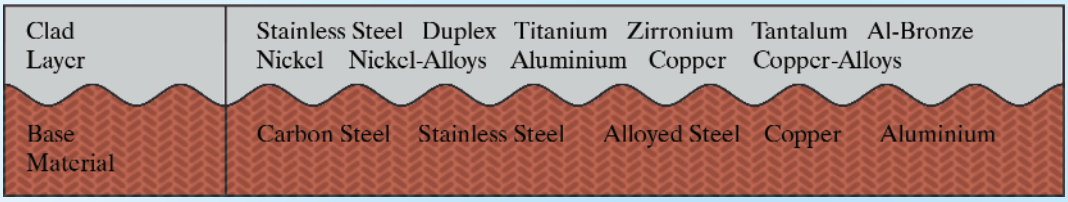
Applications

Our explosion-welded clad metals are used in different industries:

Oil and Gas
(Onshore & Offshore)
Chemical and Petrochemical
Desalination Plants
Steel mills & Hydrometallurgy
Aluminium Smelters
Shipbuilding
Power Generation
Electrochemical
Air-conditioning & Chillers
Cryogenic
Food & Beverage
Pharmaceutical
Pulp & Paper
Mining
Nuclear

Materials

The cladding metals are typically stainless steel, duplex steel, titanium, aluminium, copper, copper alloys, nickel, nickel alloys, tantalum, and zirconium.
The base metals are typically carbon steel, stainless steel, alloy steel, copper and aluminium.



Cladding Metals	Base Metals
* 300 series SS * 400 series SS * Duplex & Super Duplex * Nickel Alloys # Alloys 200, 400 # Alloys 600, 800 # Alloys 625, 825 # Alloys 900 # Alloys C-276, -22 # Alloys C-2000 # Alloys 59 # Hastelloys * Copper Alloys # Copper Nickel # Naval Brass # Aluminium # Aluminium Bronze * Titanium * Zircunium * Tantalium * Other Metals (on request)	PLATES # CS A-55, A-516, A-537 # Alloy Steel A-387, A-204 FORGINGS # CS A-266, A-350 # Alloy Steel A-387, A-204 SS PLATES & FORGINGS # 300 series

Interface Titanium / Steel
200x magnified

Product Type

- Flat plates (square/rectangular)
- Round discs (heads/tube sheets)
- Pipes / LWN.

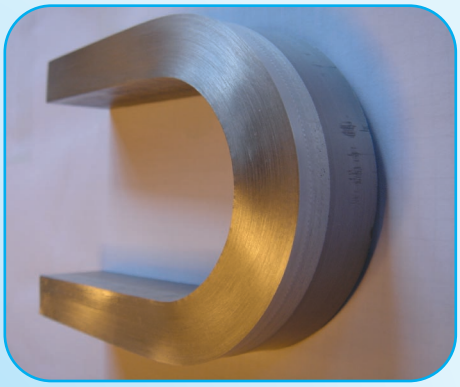
Sizes / Capacity

- Maximum Length: 11000 mm
- Maximum width: 4200 mm
- Maximum total area: 25 m2.
- Maximum piece weight: 25 MT
- Base material thickness: 1 - 500 mm
- Clad material thickness: 1 - 25 mm

Titanium Claddiscs ø3500 x (260+10)

Advantages of Explosion Cladding under Vacuum

- Short delivery time: complete production under one roof
- Excellent process control (no weather influences and circumstances)
- Because of vacuum, less explosives are required.
  As results:
  - Less deformation
  - Hardness of the clad plate slightly increase
- Costs saving: thin layer of expensive material cladded on a thicker layer of cheap material.
- Metal combinations possible which are conventional impossible to weld.
- Original metal properties maintain.
- Joint/bond stronger than the weakest material.
- Oxide free atomic bond
- Electrical resistance of anode / cathode blocks nil.
- Required clad layer thickness in 1 step realized
- Smooth surface after cladding
- Intermediate quality control not necessary

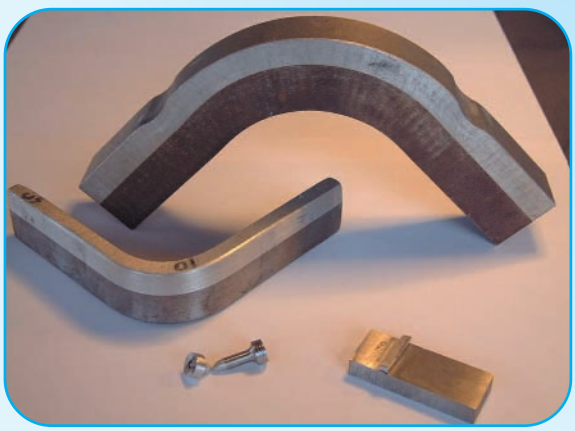


Bend Test

Fatique Test

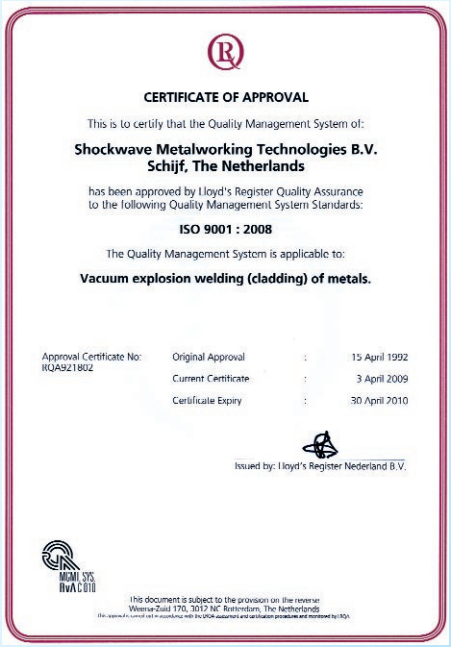
Quality & Testing

- Procedures acc. To ISO 9001 (since 1992)
- Testing of the explosive cladded material:
  - Ultrasonic Testing
  - Destructive testing:
    - # Tensile test
    - # Bend test
    - # Shear test
    - # Impact test
    - # Fatigue test



Various Test Samples

Tensile Test



CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of:

Shockwave Metalworking Technologies B.V.
Schijf, The Netherlands

has been approved by Lloyd's Register Quality Assurance to the following Quality Management System Standards:

ISO 9001 : 2008

The Quality Management System is applicable to:

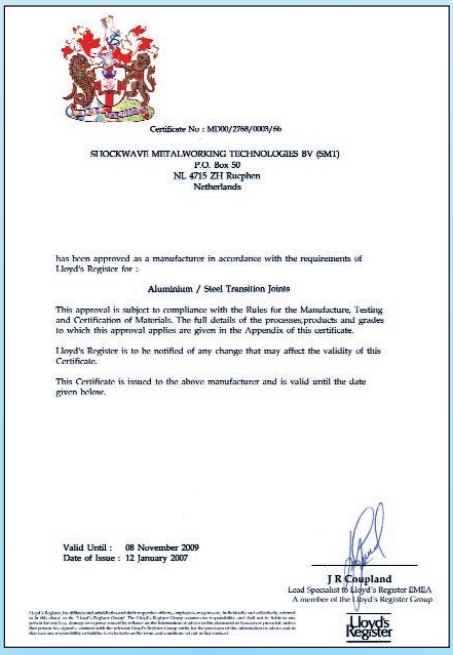
Vacuum explosion welding (cladding) of metals.

Approval Certificate No: RQA921802	Original Approval	:	15 April 1992
	Current Certificate	:	3 April 2009
	Certificate Expiry	:	30 April 2010

Issued by: Lloyd's Register Nederland B.V.

MGMT. SYS. RvA C 010

This document is subject to the provision on the reverse
Weena-Zuid 170, 3012 NC Rotterdam, The Netherlands



Certificate No : MD00/2768/0005/6b

SHOCKWAVE METALWORKING TECHNOLOGIES BV (SM1)
P.O. Box 50
NL 4715 ZH Rucphen
Netherlands

has been approved as a manufacturer in accordance with the requirements of Lloyd's Register for :

Aluminium / Steel Transition Joints

This approval is subject to compliance with the Rules for the Manufacture, Testing and Certification of Materials. The full details of the processes,products and grades to which this approval applies are given in the Appendix of this certificate.

Lloyd's Register is to be notified of any change that may affect the validity of this Certificate.

This Certificate is issued to the above manufacturer and is valid until the date given below.

Valid Until : 08 November 2009
Date of Issue : 12 January 2007

J R Coupland
Lead Specialist for Lloyd's Register EMEA
A member of the Lloyd's Register Group

Lloyd's Register

CERTIFICATE OF APPROVAL OF MANUFACTURERS OF MATERIALS
No. FAB157806XN/001

This is to certify that the manufacture of the product identified below is in compliance with the applicable requirements of the RINA Rules for the Approval of Manufacturers of Materials.

Description	**Explosion bonded aluminium/steel transition joints**
Type	**TRIPLATE**
Manufacturer	**SHOCKWAVE METALWORKING TECHNOLOGIES BV**
Place of manufacture	**SCHERPENBERGSEBAAN 49** **4721ST SCHIJF** **NETHERLANDS**
Reference standards	**RINA Rules for the approval of manufacturers of materials**

Issued in **ROTTERDAM** *on* **November 26, 2008**. *This Certificate is valid until* **November 26, 2011**

RINA
Dario Bruni

This certificate consists of this page and 1 enclosure

RINA Società per Azioni
Via Corsica, 12 - 16128 Genova
tel. +39 010 53851
Fax +39 010 6007000

DNV

DET NORSKE VERITAS
APPROVAL OF MANUFACTURER
CERTIFICATE

CERTIFICATE NO. AMM-3962

This is to certify that
S.M.T. Shockwave Metalworking Technologies B.V.
RUCPHEN, Netherlands

is an approved manufacturer of
Explosion Bonded Aluminium/Steel Transition Inserts

in accordance with
Det Norske Veritas' Rules for Classification Pt. 2

and the following particulars:

Steel grade	NV D36 or equivalent
Aluminium grade	NV 5083
Intermediate layer	Al alloy Al 99.5

Place and date
Høvik, 2009-02-11
for DET NORSKE VERITAS AS
Hanne Anita Hjerpetjønn
Head of Section

DET NORSKE VERITAS 1864

Local Office
DNV Rotterdam

This Certificate is valid until
2011-06-30
Sastry Yagnanna Kandukuri
Surveyor

DET NORSKE VERITAS AS · VERITASVEIEN 1, 1322 HØVIK, NORWAY · TEL: (+47) 67 57 99 00 · FAX: (+47) 67 57 99 11
Form No.: 20.90a Issue: January 98 Page 1 of 1

- Independent inspection authorities: Lloyd's, TUV, Stoomwezen, GL, DNV, ABS, Bureau Veritas, etc.
- Certificates acc. to EN 10204 3.1. A, B, C of 3.2.

Our Market Areas

We are proud To serve you

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