

MM-Info „Energy“

Info folder with branch specific information of chosen PolymerMetals
for customers from the energy sector



MultiMetall
the MetalExistenceCompany®

PolymerMetall® • MultiMetall® • Ceramium® • Molymetall® • Sealium® • XETEX®

MultiMetall is the manufacturer of PolymerMetall®.

For more than 40 years MultiMetall invests in polymer-metallic material technologies for the maintenance of metals and alloys.

In the fight with these special tasks our polymer-metallic materials are professionally equipped.

Tough hard, wear resistant and long-lived – even under more difficult conditions.

Successful on oily or under water lying repair areas.

Good to exceptionally good is the assessment as per certificate 301954. (Lloyds Register of Shipping)

Superiority due to mechanical physical data, which counteracts the constant load.

The continuous compressive strength under load can be more than 160 MPa.

A force of 245 MPa is necessary to reach the upper limit. (test report Fraunhofer Institut Germany)

Difficult to damage when attacked by chemicals e.g. acids, alkaline solutions, solvents, salts, gases etc.

PolymerMetall® has a high potential of research and development.

The equipment that lets metals live longer.

MultiMetall

the MetalExistenceCompany®



PolymerMetall® for the repair of metallic devices

www.polymermetal.com

MultiMetall

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PolymerMetall®

Introduction

MultiMetall Germany invests for more than 40 years in polymer-metallic material technologies for the maintenance of metals and alloys. In plants and constructions often functional particularly important components are exposed to stresses like break, tear, corrosion, cavitation, chemical or thermal demands. Components treated with PolymerMetals can be preventatively protected against above mentioned stresses. Furthermore MultiMetall's cold repair technology facilitates a gentle material treatment and a durable repair of damaged parts.

Wherever technical security is concerned, PolymerMetals offer the required quality. Certificates from classification societies, test results from research laboratories as well as positive evaluations from customers worldwide verify that fact. Even at problematic surfaces, on oil, grease, fuel or under water, PolymerMetals are used. This technology is called „direct-MM-bonding“.

PolymerMetals - Excellent properties

Engineers and technicians need to have a clear picture of the quality of the products available on the market to be able to choose the best product. Therefore we decided to list excellent properties of different MultiMetall-products in the following overview. Please make your own comparison and let the figures speak for themselves.

Compressive strength (DIN ISO 604):	211 MPa
Compressive strength after post-curing (DIN ISO 604):	245 MPa
Flexural strength (DIN 53452):	110 MPa
Hardness (DIN 50351):	55 Brinell
Modulus of elasticity at 20 °C (DIN EN ISO 6721-5):	15.600 MPa (2.262.000 psi)
Modulus of torsion at 20 °C (DIN EN ISO 6721-2):	5.900 MPa (855.500 psi)
Corrosion:	none
Electrochemical corrosion (DIN 50900):	none
Resist against internal pressure:	300 bar
Totally cured at temperatures up to:	minus 30 °C
Total curing time:	3 min
Repairs in high temperature range at metal temperatures up to:	300 °C
at water cooled metal surfaces up to:	550 °C
Repairs of all metals and alloys	
Application of oily, greasy or fuel contaminated metal surfaces	
Application under water or on wet metal surfaces	
Surface protection against erosion, abrasion, cavitation & corrosion	
Chemical resistance very high against acids, lyes & solvents	
Storage over 5 years without any loss of quality possible	

Acceptance by classification societies

American Bureau of Shipping • China Classification Society • Det Norske Veritas • Germanischer Lloyd • Lloyd's Register of Shipping • Nippon Kaiji Kyokai • Russian Type Approval

Availability

Technical data sheets are generally available in German or English language. PolymerMetals are only produced in Germany and delivered worldwide within short time by MultiMetall. In addition to that our products are internationally available from many MultiMetall-partners. Ask for further products from MultiMetall.

Repair of components with PolymerMetals

air sleeves • axles • bearing housings • bearing seating • boiler • bridge bearings • compensators • compressors • condensers / capacitors • conveyor belts • cooling tubes • cyclone • cylinder barrels • cylinder sleeves • engine blocks • engines • exhaust pipelines • exhaust pipes • exhaust turbines • gaskets • gearbox housings • guide rails • heat exchangers • housings for gas inlet and outlet • hulls • hydraulic cylinders • hydraulic oil pipes • hydraulic pistons • impellers • kort nozzles • oil coolers • oil pipelines / oil feed pipes • oil tanks • petrol pipelines / petrol feed pipes • petrol tanks • plain bearings • plungers • propellers • pumps • rudder bearings • seals • shaft plates • shafts • slab frames • spline shafts • steam pipelines / steam feed pipes • tappet guides • transformers • turbine housings • turbochargers • V-grooves / keyways • valve housings • valves • vibration dampers • water coolers • water pipes • water tanks

Trademarks

MultiMetall®
PolymerMetal® • Ceramium®
Molymetall® • Sealium® • XETEX®

Reference list (Extract of German customers)

ABB AG • AG der Dillinger Hüttenwerke • AIDA Cruises • Alstom Power Service GmbH • Atlas Copco Energas GmbH • Blohm + Voss Industrietechnik GmbH • Bombardier Transportation GmbH • BVG Berliner Verkehrsbetriebe • Carl Büttner Ship Management • Continental AG Automotive Systems • Daimler AG • DB AG • Deutsche BP AG • Deutz AG • E.ON AG • ENSO Energie Sachsen Ost AG • Erdgas Südsachsen GmbH • Europipe GmbH • Evonik Power Saar GmbH • German Tanker Shipping GmbH & Co. Ship Owners & Tanker Operators • HeidelbergCement AG • Henschel Industrietechnik GmbH • HKM Hüttenwerke Krupp Mannesmann GmbH • Holborn Europa Raffinerie GmbH • IVECO Motors FPT Deutschland • K + S KALI GmbH • KKW Krümmel • KKW Brokdorf • KS Aluminium-Technologie GmbH • KSB AG • LEW Lechwerke AG • LH Luitpoldhütte AG • MAN Diesel SE • Metalock Industrie Service GmbH • MTU Friedrichshafen GmbH • N-ERGIE AG • Norddeutsche Reedereien H. Schuldt GmbH & Co KG • PCK Raffinerie GmbH • Peiner Umformtechnik GmbH • Pirelli Kabel & Systeme GmbH & Co.KG • Porsche AG • Ruhrpumpen GmbH • RWE AG • Saarstahl AG • Salzgitter AG • Shell Deutschland Oil GmbH • Siemens AG Power Generation • Stadtwerke München • Stadtwerke Trier • ThyssenKrupp Industrieservice GmbH • ThyssenKrupp Marine Systems Blohm & Voss Repair GmbH • ThyssenKrupp Steel Europe AG • Vattenfall Europe AG • ZF Friedrichshafen AG

MultiMetall

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Overview product range

MM-metal SS-steelceramic

MM-metal SS-steelceramic is the PolymerMetal with the widest range of application for repairs and maintenance of all metals and alloys. MM-metal SS-steelceramic offers a very high quality at mechanical repairs of damaged components (e.g. caused by crack, corrosion, abrasion, impact or chemical stress).

Machinability: SiC-grinding plates, Diamond tools

MM-metal SQ

Characteristic for this PolymerMetal are the easy processing and extreme short curing time. The variable mixing ratio offers application consistencies from pasty to liquid. MM-metal SQ can be used at ambient temperatures up to minus 30 °C.

Machinability: standard tools

MM-metal SS-steel 382

MM-metal SS-steel 382 is a PolymerMetal and construction material. The high performance material MM-metal SS-steel 382 delivers the best technical data under mechanical and physical stress.

Machinability: standard tools

MM-metal SS

PolymerMetals of the SS-basis possess very high quality standards for the reconstitution of metallic components. These PolymerMetals are available with the alloy materials steel, aluminium, copper and bronze.

Machinability: standard tools

MM-metal oL-steelceramic

MM-metal oL-steelceramic is a PolymerMetal tested and certified for the repair of oily, greasy or fuel contaminated metals and alloys in case of stress due to cracks, corrosion, abrasion, impact or chemicals. MM-metal oL-steelceramic can also be used to seal oil, grease or fuel pouring from leaks at systems under pressure.

Machinability: SiC-grinding plates, Diamond tools

MM-metal UW

MM-metal UW is a PolymerMetal with extreme short curing time. It is certified for repairs under water or on wet metal surfaces. Possible application areas of MM-metal UW are the repair of under water components or the sealing of leaks. MM-metal UW can also be used to seal water pouring from leaks at systems under pressure.

Machinability: SiC-grinding plates, Diamond tools

Ceramium®

Ceramium offers maximum wear resistance against continuous material loss on metallic surfaces. With tough hard layers, Ceramium protects against erosion, abrasion, cavitation or corrosion in case of dry or wet or chemical stress.

Machinability: SiC-grinding plates, Diamond tools

Ceramium® CH

Ceramium CH is a wear resistant Polymer-Ceramic with excellent resistance against chemicals. These include inorganic (mineral) and organic (carboxylic) acids - also in concentrated form – as well as halogenated and aromatic hydrocarbons, ester, ketone, alcohols, bases and oxidising salt solutions.

Machinability: SiC-grinding plates, Diamond tools

XETEX® BD

XETEX BD is a cold-setting two-component construction adhesive on basis of epoxy resin / ceramic, which has been developed for high-strength bonding. The application is the joining of materials (e.g. metals, ceramics and plastics) with very high strength at high mechanical, static and dynamic loads.

VP 10-017

VP 10-017 is a tough elastic PolymerCeramic with high impact and cavitation resistance. This extremely smooth surface protection provides a good resistance against chemicals and has a high mechanical-physical load capacity.

VP 10-500

VP 10-500 is a PolymerMetal for repair and maintenance of metals in the high temperature range. It is a hot-hardening material which does have a clearly higher temperature resistance than cold-hardening polymer materials. A high chemical resistance especially against sulphuric acid is given.

Machinability: SiC-grinding plates, Diamond tools

Molymetall®

Molymetall is a PolymerMetal with a very low coefficient of friction and self-lubricating properties. The emergency running properties against solid dry friction such as sliding wear and stick-slip are excellent. After curing, Molymetall can be processed to a finished measure up to the μ -area.

Machinability: standard tools

Sealium®

Mostly Sealium is used as sealant and sealing of metallic casting materials. Furthermore alloys and thermal coated components can be treated with Sealium. As a one-component material with extremely high capillary activity, Sealium penetrates micro-porosities or hairline cracks and reacts in the structure of the metallic material.

MM-metal S

PolymerMetals of the S-basis are used for removing bubbles in cast parts, for quick repairs and for visual improvements. MM-metal is available with high metal filling particular for the cast materials steel, iron, aluminium, copper and bronze.

Machinability: standard tools

MM-Elastomer

MM-Elastomer is a material with rubber-like characteristics. Using MM-Elastomer elastic connections can be created or components repaired which are e.g. subject to abrasion. The range of MM-Elastomer goes from Shore A hardness 40 to 95.

PolymerMetall® • MultiMetall® • Ceramium® • Molymetall® • Sealium®
XETEX® • the MetalExistenceCompany®
are registered trademarks of MultiMetall



Advantages of a transformer repair carried out with PolymerMetall® compared to a repair with conventional welding

- Welding is often impossible due to specific dangers of fire
- When welding oil leakages, certain pin porosity develops due to the combustion of oil in the sealing joint, which will lead to corresponding leakages later
- Through welding, the protection against corrosion in and around the repair area will be eliminated, especially on new equipment
- No distortion of welding because of high heat supply; no emitting of internal tension at the transformer tank due to the influence of heat
- With the use of the PolymerMetall® MM-metal oL-steelceramic, the protection against corrosion will be improved; no crevice corrosion
- Short time for preparation and realisation (setting up of vacuum and drain of oil not required!)
- The substantial reduction of repair time leads to lower repair and breakdown costs
- Easy and small dosage (~ 50 g) possible with the use of measuring spoons to avoid unnecessary waste of material
- Storage stability of a minimum of 5 years even after several openings
- Repair method worldwide successful for many years

MultiMetall invests in polymetallic material technologies for the maintenance of metals and alloys for more than 40 years.

MM-metal oL-steelceramic for the repair on oily surfaces; certified by Lloyds Register of Shipping (certificate 301954).

www.metalexistence.com/transformer

PolymerMetall® for the repair of metallic devices



MultiMetall
the MetalExistenceCompany®



Technical Report PolymerMetal®

TEC-# 017

Elimination of oil leaks from electrical components like transformers, shunt reactors, transducers, etc.

Used products

MM-metal oL-steelceramic, MM-Elastomer

Introduction

The laws and requirements for environment protection determine, that no oil should leak out of the operating electrical machinery and plants. This demands that tightness of seams and flange connections are checked during inspections on regular basis. Power transformers are particularly vulnerable due to their construction, which has oil reservoirs, oil connections, large number of seams and age of the sealing material. By usage of cold curing PolymerMetals and MM-Elastomer a part of these oil leakages can be eliminated on the site itself.

Repair possibilities for PolymerMetals and MM-Elastomer

Transformers	Flange connections	Switches
Pumps	Shunt reactors	Condensers
Cables	Oil reservoirs	Cable boxes
Bushings	Transducers	

PolymerMetals

PolymerMetals are pasty, liquid or brushable materials, which are subjected to a special chemical process with the hardener (Polyaddition) right before processing. The polymers, which are a combination of resin, filler and additives, are processed in a specific way. By the mixing of the basis material and the hardener the PolymerMetals do totally cure and achieve properties similar to metal. The choice of the combining components dictates the final quality of the material and its characteristic profile.

When the repair of electrical components is necessary often it can't be done by welding or soldering because of specific dangers of fire etc. More favourable and often only possible is a repair with PolymerMetals.

The liquidation of oil leakages at the repair site is possible, because a special PolymerMetal is applied to oily work pieces or work pieces contaminated by grease or petrol, where colour rests have been removed from. This PolymerMetal is not applied to a cleaned or prepared metal surface as common for most other materials. By applying the PolymerMetal that means working it up onto the metal surface an excellent bonding is reached.

Most important applications of PolymerMetals at electrical components

- Sealing of oil leakages on seams under oil pressure (e.g. on transformers, shunt reactors, transducers or oil-conservators)
- Sealing of air pressure leaks on seams (e.g. on compressed air lines, other compressed air equipment)
- Sealing of SF₆ leaks
- Repair of bushings and ducts on mounting flanges
- Repair of oil filled frames (e.g. gearboxes, transducer frames)
- Repair of bushings for high voltage cables which are laid underground and display oil

leakages

- Repair of porcelain insulators with damaged parts
- Repair of coils

MM-Elastomer

The cold curing MM-Elastomer is a polyurethane based on polyisocyanate. This process helps to produce an oil resistant material from high grade polyurethane. Shortly before processing the pasty or liquid basis component is subjected to a chemical process (polyaddition) by adding a hardener. Hereby the MM-Elastomer does totally cure and acquires rubber like properties. The elasticity and abrasion resistance of MM-Elastomer (Shore A hardness = 95, 85, 65 or 40) can reach values better than conventional rubber. Whenever MM-Elastomer is used there is not necessary any primer. When subjected to elongation or compression, MM-Elastomer reverts back to its original shape and has a high electrical and chemical resistance. Basis of MM-Elastomer's multipurpose usage is the good bonding on rubber, metal and ceramics and sufficient bonding on pvc, polycarbo-nate, neoprene, fibreglass, glass, plywood and similar materials. The operating temperature of MM-Elastomer is limited to 130 °C (=266 °F).

Surface preparation

- Make the surface metallically clean and carriable
- Mechanically rough up the surface by sandblasting, cutting, grinding etc.
- Clean again by sweeping, blowing off, evaporating
- Thoroughly degrease with MM-Degreaser Z or do bind the oil with the PolymerMetal MM-metal oL-steelceramic
- When applying on rubber just mechanically rough up and clean the surface
- Apply a thin layer of MM-Release agent on surfaces, where a compound with the PolymerMetal should not be formed and polish after a short drying period

MM-Elastomer should be carefully mixed with the Hardener under consideration of the recommended mixing ratio and applied to the prepared surface. The exact application procedure will depend on the type and extent of the oil leak.

Repair methods

method1: There is slow oil leak from the seat of the damage, which reappears after about one hour of degreasing operation. In this case, repairs are done directly with MM-Elastomer after degreasing the seat of the oil leak. By the time the oil reappears at the leaky point again, the MM-Elastomer would have been cured enough to bond to the seat of damage. This type of repair is applicable to oil leaks between head and diverter-switch-vessel of a transformer. It should be considered that MM-Elastomer covers the sealing edges and overlaps the flanged edges as well.





method2: This is a situation where oil pours out immediately or within a short period again after sweeping away from the leakage. This method should be chosen when the component is loaded by switching or vibration. First the oil must be binded with the PolymerMetal MM-metal oL-steelceramic. Then an overlapping coating with the cold hardening MM-Elastomer should be applied to the PolymerMetal.

method3: In this case an oil jet is coming out of the leakage. Here the repair site must be made pressure-free. This could be done by e.g. valving off the leakage, creating a vacuum at transformers, self tapping screws, calking, etc. If the leakage occurs at a position where there isn't enough surface e.g. at the edge of a heat exchanger, further assisting materials e.g. fabric tape should be used.



method4: Situations, where the damaged components are not subjected to vibration, or any other movements, oil leaks can be repaired by application of the PolymerMetal MM-metal oL-steelceramic alone.



Summary

Main users in electric industry are big power plants, heating and power stations, electricity stations, substations, repair departments of the energy supply companies, electric railway stations and similar companies and service companies. PolymerMetals and MM-Elastomer are not electrically conductive and can therefore be used as protection against corrosion, too. After full curing they can normally be metal-cutted. Depending on the hardness of the used PolymerMetal there can be used Diamonds or SiC-grinding plates or normal tools.

MultiMetal

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Technical Report PolymerMetal®

TEC-# 006

Microscope photographs, direct-MM-bonding, bonding on contaminated surfaces, pressure tight tests

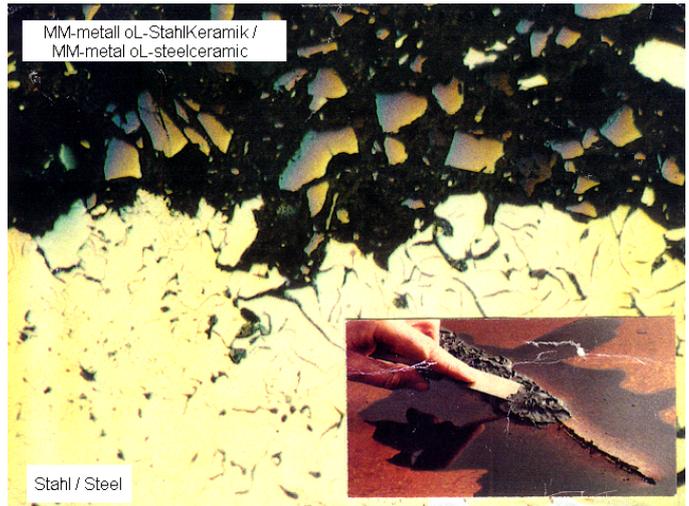
Used products

MM-metal oL-steelceramic

Description

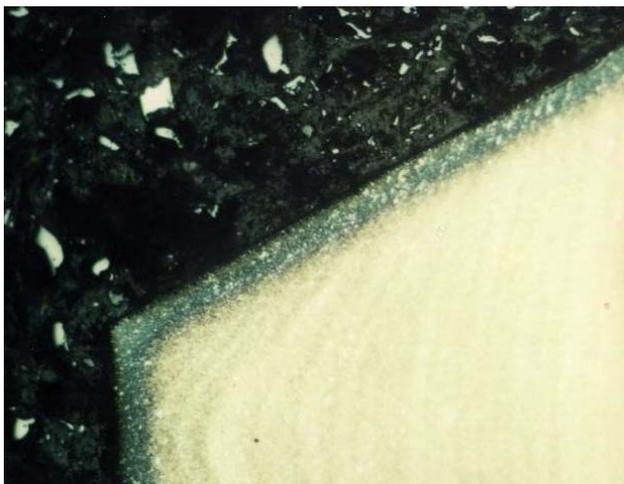
MM-metal oL-steelceramic is a PolymerMetal tested and certified for the repair of oily, greasy or fuel contaminated metals and alloys in case of stress due to cracks, corrosion, abrasion, impact or chemicals. The degree of soiling does not in any way affect the bonding with the structure of the soiled metal surface. High technical data and also the chemical resistance and bonding with the structure on a dirty metallic surface are remarkable features of MM-metal oL-steelceramic.

This technology is approved by Lloyd's Register of Shipping.



Microscope photographs / direct-MM-bonding

The following pictures show microscopic photographs of the fully cured PolymerMetal MM-metal oL-steelceramic magnified by a factor of 100 and 500. Here the bonding between MM-metal oL-steelceramic and metallic surfaces (steel or casting), which have been contaminated by various applied oils before, has been analyzed.



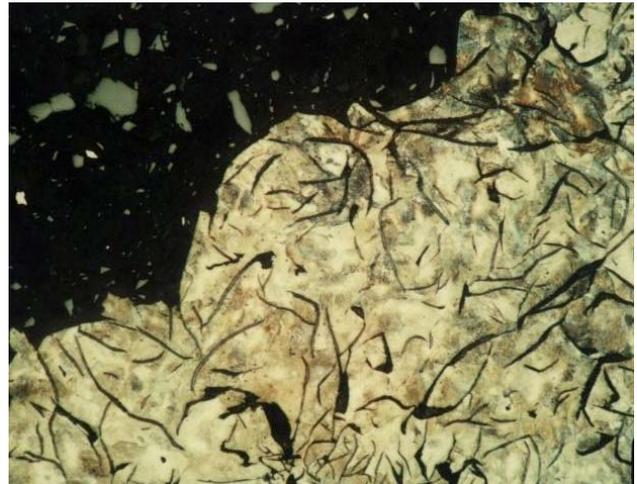
on industry gear oil / steel
(Magnification 100)



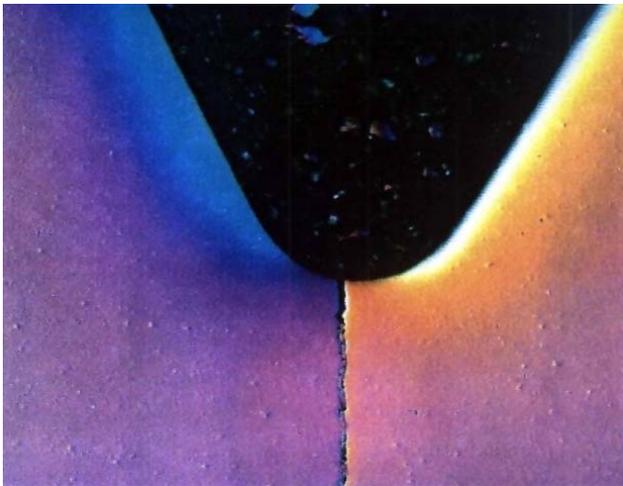
on petroleum / casting
(Magnification 100)



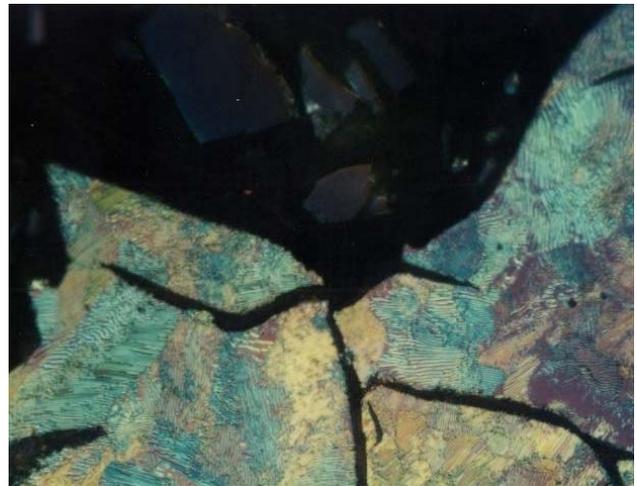
on diesel / steel
(Magnification 100)



on compression oil KSL 68 / casting
(Magnification 100)



on hydraulic oil T 29-50 / steel
(Magnification 100)

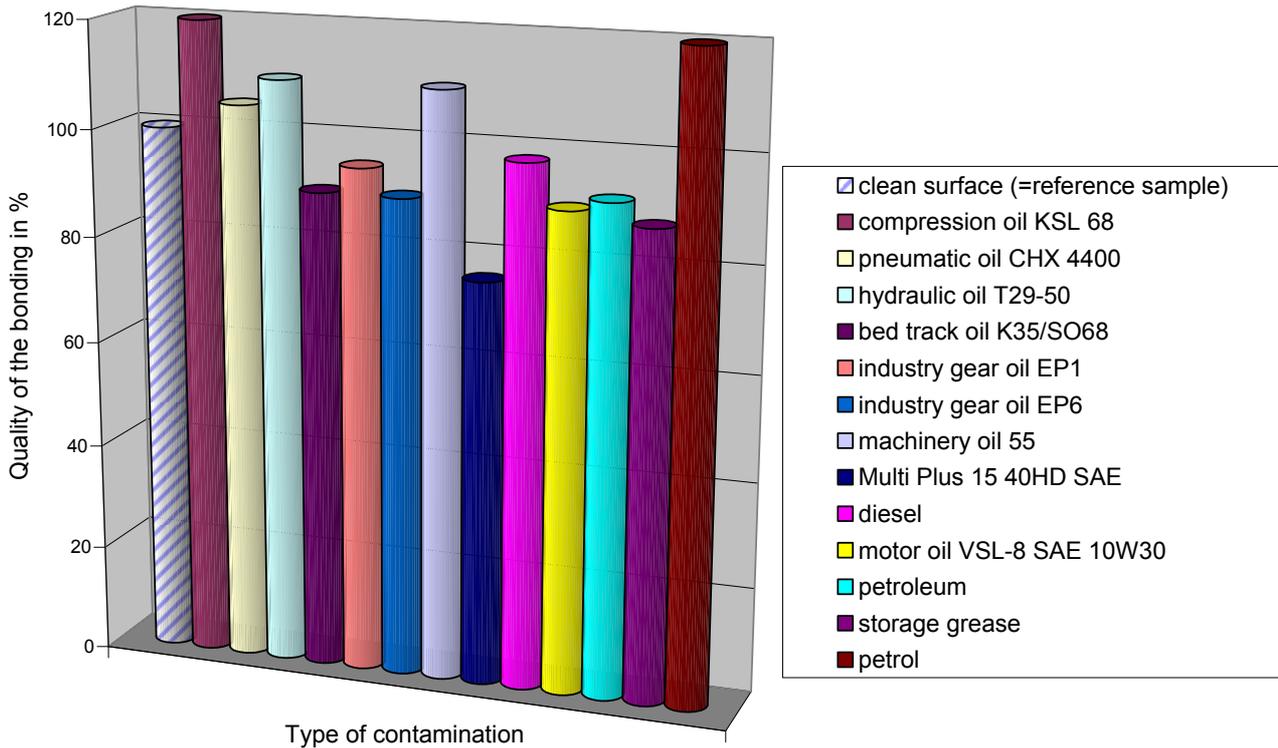


on gear oil / machine oil 55
(Magnification 500)

MM-metal oL-steelceramic penetrates and absorbs oil, grease and fuel. The direct-MM-bonding technology secures the direct and high solid bonding on contaminated surfaces.

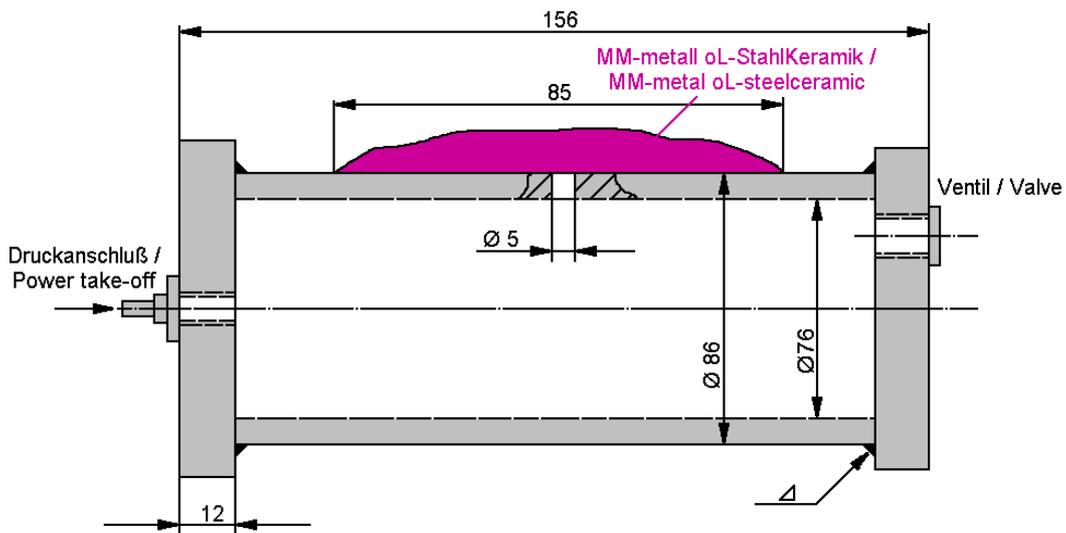
Bonding on oily surfaces

Tests have been carried out to evaluate the quality of the bonding on different surfaces. At the reference test MM-metal oL-steelceramic and Hardener yellow have been applied to a cleaned (that means oil free) and roughened metal surface. The reference value of 100% stands for the quality of the various determined technical data during bending, shearing & hydraulic tests after total curing time. Other values have been determined by applying MM-metal oL-steelceramic on different contaminated metal surfaces. The test results demonstrate that sometimes better technical values were reached after application on oily metal surfaces than on clean metal surfaces.



Testing of pressure tightness

To be able to evaluate the quality of the application of MM-metal oL-steelceramic on oily surfaces, tests have been carried out at company M.A.N. under supervision of the classification society Lloyds Register of Shipping. Here special test pipes made off steel have been created according to the following drawing. Around a leakage of a size of diameter 5 mm the metallic shiny surface (Rz 65 μm) of the test cylinder was contaminated with oil. Then the cold-curing MM-metal oL-steelceramic with Hardener yellow was applied around the leakage with a layer thickness of up to max. 8 mm. After full curing of the PolymerMetal the test cylinder has been filled with a liquid and pressure was built up. Then the system was checked against pressure tightness.



Pressure	Temperature of test cylinder	Auxiliaries	Result
100 bar	20 °C	-	pressure tight
150 bar	20 °C	-	pressure tight
200 bar	20 °C	-	after 8 hours small leakage

In the course of the time the research and development division of MultiMetall was successful to continue optimising the material MM-metal oL-steelceramic and new tests with same conditions have been carried out at MultiMetall. The following results were achieved:

Pressure	Temperature of test cylinder	Auxiliaries	Result
200 bar	20 °C	-	pressure tight
300 bar	20 °C	-	pressure tight
350 bar	20 °C	-	after 2 hours small leakage
150 bar	75 °C	pipe clip	pressure tight
400 bar	75 °C	pipe clip	pressure tight

The pipe clip was fixed around the test cylinder in the area of the leakage. Reinforcing elements as e.g. fibres or mats consisting of glass or carbon have not been used. These would have increased the physical strength essentially.

The tests have been carried out at M.A.N. (test report No. 1731/82) under supervision of Lloyds Register of Shipping (certificate No. 301954) in 1982, the test at MultiMetall in 1995.

Extract of the certificate: „The test results of MM-metal oL-steelceramic may be classed as ranging from good to exceptionally good. All test results were in support of the maker’s claim that MM-metal oL-steelceramic will bond on oily surfaces with a high degree of reliability.”

Practical example

At Weatherford pressure tests have been carried out with MM-metal oL-steelceramic. The test piece was pressure tight up to a tested pressure load of 4.000 psi (~ 275 bar).

Here are some photographs incl. test records:





Weatherford CDL 9405R1c)

Program : 1.58
 Date : 900025
 Part No. : 0
 Serial No. : 0
 Assembly : 0

Acquiring Date 21.01.2006
 Acquiring Time 11:00:03

Admin Data

Company ACOTS
 Order no. KLAUS
 Operator

Pipe Data

Pipe Type 31/2" PIPE
 Manufacturer
 Pipe Diameter
 Weight
 Grade
 Lubricant
 Comment

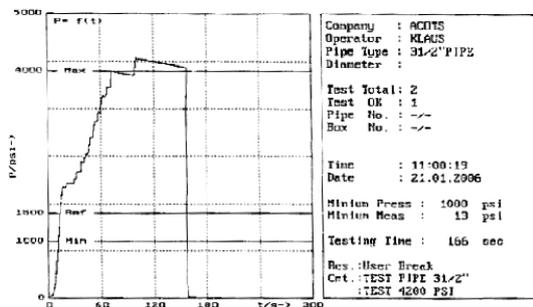
Pressure Values

Pressure Range 5000 psi
 Max. Pressure 4000 psi
 Min. Pressure 1000 psi
 Ref. Pressure 1500 psi

Sensor Data

Sensor Type
 Sensitivity (mV/V) 2.000

Weatherford CDL 9405R1c) Ver. 1.30 Date 900025



Further information can be provided upon request.

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The product information and instructions provided in this leaflet were prepared to the best of our knowledge and serve information purposes only. We recommend that appropriate tests are carried out prior to application in order to ensure that the products and methods fulfil the purpose desired by the user. In this procedure, the given data may serve as a basis. Application and processing of the products lie outside our possible control and are therefore the sole responsibility of the user.

Technical Report PolymerMetal®

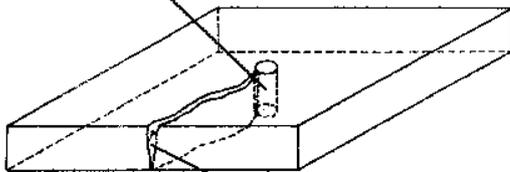
TEC-# 016

Sample applications

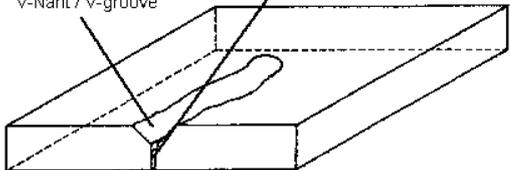
Used products

PolymerMetals

Rissende ausgebohrt / crack end drilled out



V-Naht / V-groove



Riss / Crack

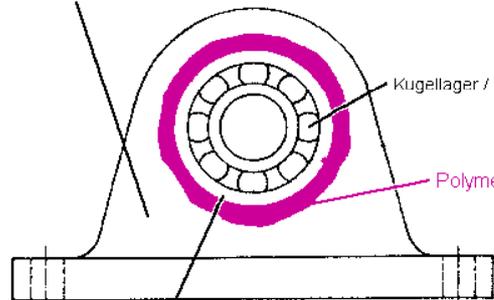
appliziertes PolymerMetal /
applied PolymerMetal



Reparaturstelle nach Bearbeitung /
Repair site after machining



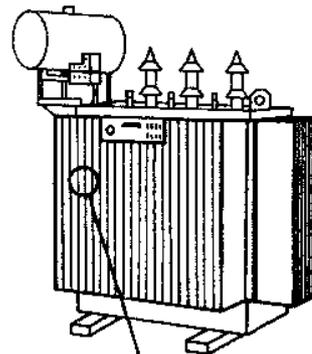
Lagerblock / pillow block



Kugellager / Ball bearing

PolymerMetal

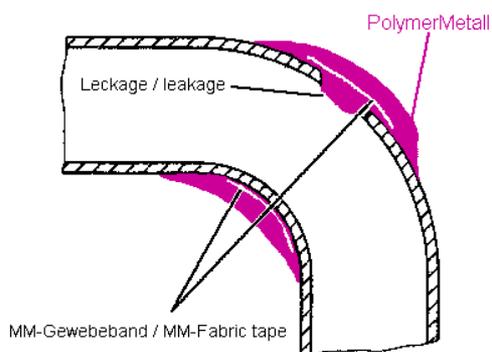
MM-Trennmittel / MM-Release agent



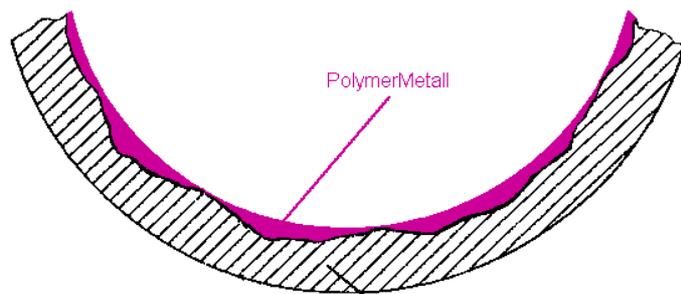
PolymerMetal



Leckage mit Flüssigkeitsaustritt /
leakage with liquid pouring out



MM-Gewebeband / MM-Fabric tape



verschlissenes Pumpengehäuse / worn pump casing

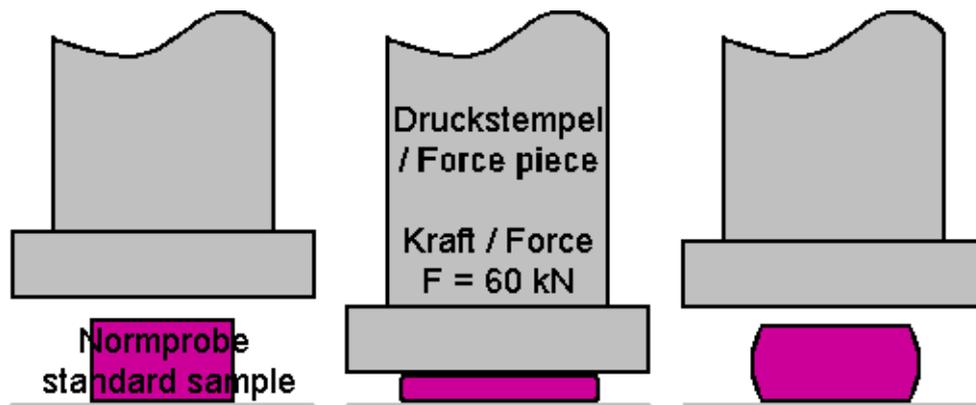
MultiMetal
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TEC-# 015

Compression strain test

Used products

MM-Elastomer



Description

As you can learn from this test, MM-Elastomer disposes high impact strength, hardness and low distortion rest despite of this high use. Furthermore no cracks or excavations could be found after the test. MM-Elastomer is especially suitable for the production of shock and vibration absorbers, cyclone coatings and for the repair of pumps, containers, seals and conveyor belts.

MultiMetal
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TEC-# 026

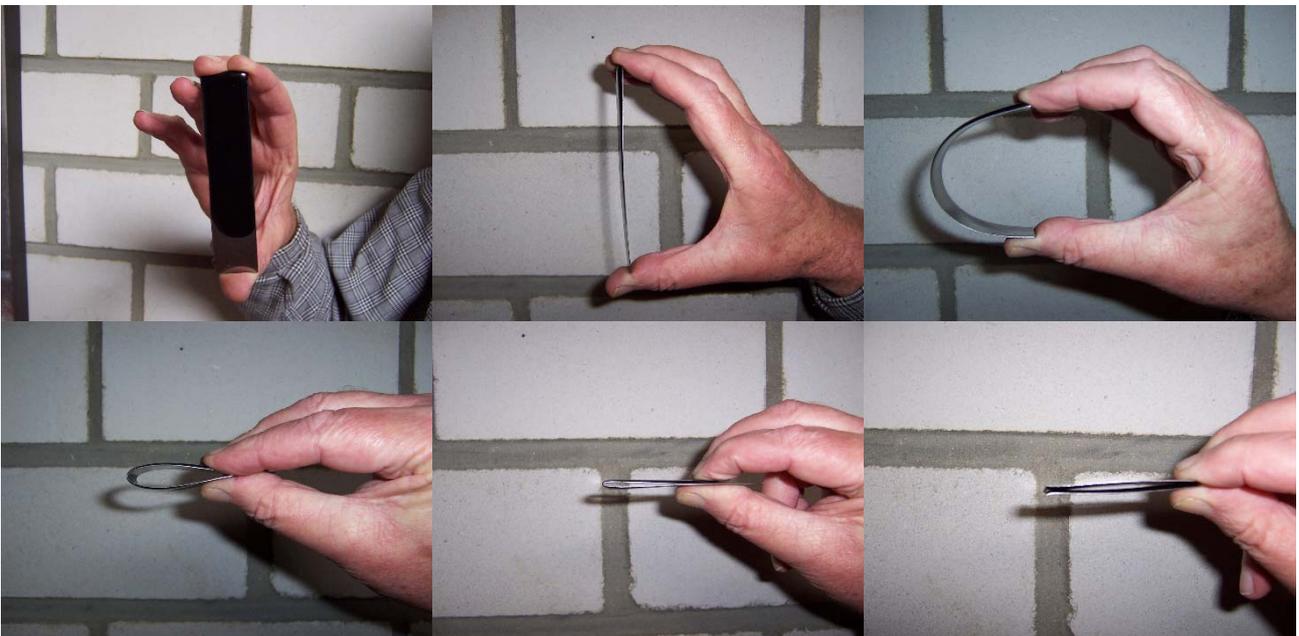
Adhesion & elasticity

Used products

MM-Elastomer 95

Description

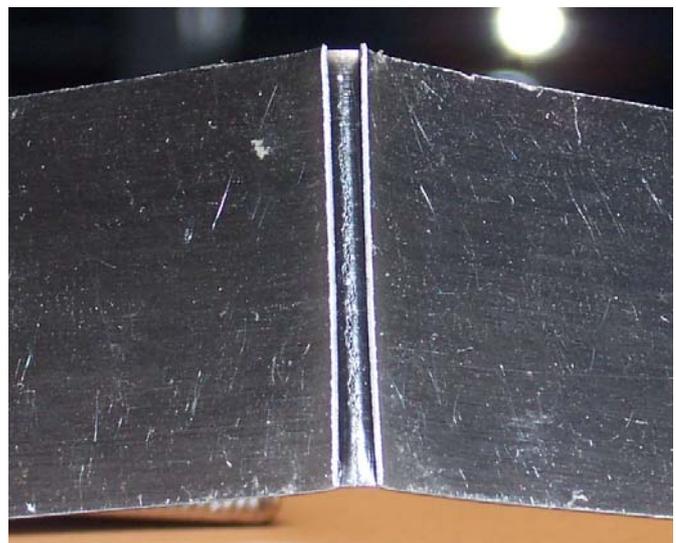
A flexible steel sheet with 0,3 mm thickness has been roughened up and degreased. Afterwards MM-Elastomer 95, liquid together with Hardener EL95 was applied to the sheet in a layer thickness of 2 mm. After full curing of the MM-Elastomer, the steel sheet was bended until it was broken.



Result

The test shows that the MM-Elastomer establishes an extremely good bonding with the metallic surface of the steel sheet even after the break of the sheet. Remarkable is that for the use of MM-Elastomer neither primer nor bonding agent is required.

The photograph on the right side shows a close-up of the bottom side of the steel sheet with the applied MM-Elastomer at the broken part of the sheet. You can see that the two broken sheet parts are still joined together by the MM-Elastomer.



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Technical Report PolymerMetal®

TEC-# 007

The corrosion-chemical behaviour of PolymerMetals in combination with casting material (contact corrosion)

Used products

MM-metal SS-steelceramic / MM-metal SQ / MM-metal SS-steel 382 / MM-metal SS-steel / MM-metal oL-steelceramic / MM-metal UW / Ceramium® / MM-metal S-steel

Introduction

PolymerMetals are used for repairs of metallic constructions which were damaged by physical loads like tear, impact, erosion, abrasion, corrosion and cavitation or by chemical load.

Questions of customers concerning the contact corrosion of our PolymerMetals lead us to do tests.

The following report shows how the test has been carried out and what results have been obtained. Tests have been made with seven different PolymerMetals in artificial sea water (laboratory test) as well as in aggressive marshy soil. The PolymerMetals used were potentially equivalent or potentially superior to the base material (cast iron).

Place of repair

Moorland in the North of Germany and laboratory

Preparation of test samples

56 plates measuring 150 x 95 x 25 mm and 95 x 47 mm have been cut off cast iron. The surface of 23 plates has been treated mechanically. 2-3 bore holes of different diameters were installed in order to create different proportions between cast iron and PolymerMetals.

General information

An ordinary salt spray test proved insufficient. As the tested PolymerMetals are non-electrical conductive products it was decided not to measure the current density potential curves. The contact resistance in the Meg-Ohm-sphere was too high.

Test in moorland

Marshy soil is to be said very aggressive (DVGW rating no. -15 up to -19)

Reasons are:

- very low soil resistance (appr. 950-1200 Ohm x cm)
- very high salt content (chloride 800 - 1250 mg/kg / sulphate 4300 - 19000 mg/kg)
- very high moisture contents (appr. 55 - 85%)
- anaerobic conditions, proved by hydrogen-sulphide

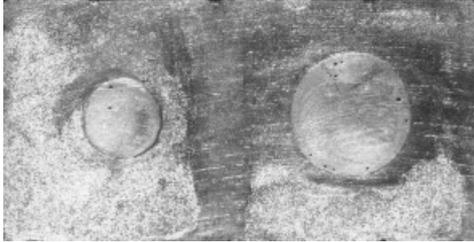
The cast iron plates and PolymerMetals, machined and non-machined, were stored in a considerable depth of marshy soil for more than one year.

Test in artificial see water (laboratory test)

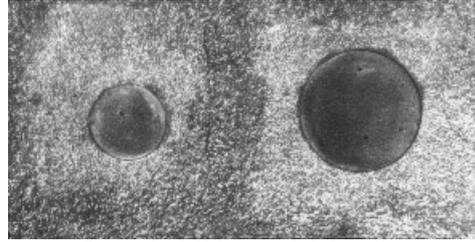
The cast iron plates and PolymerMetals - machined and non-machined - were stored in a laboratory in considerable depth of artificial sea water (DIN 50 900) for more than one year.

Samples

The following photographs show the different PolymerMetals applied to cast iron which have been partly machined after full curing. After they have been stored for 12 months in aggressive moorland or artificial sea water the samples have been examined. The following four photographs concern machined samples which have been exposed to artificial sea water:



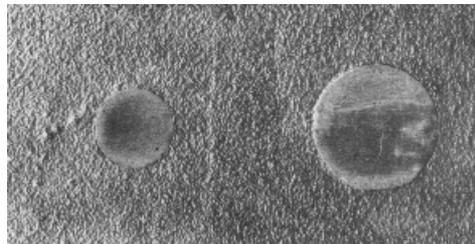
Sample MM-metal SS-steelceramic



Sample MM-metal SS-steel



Sample MM-metal oL-steelceramic



Sample MM-metal UW

Result

The results of both tests were nearly the same. Due to the strong reaction caused by the aggressive soil or by the sea water the cast iron plates were coated with ferric hydroxide. While the surface of the cast iron plates were differently affected, the PolymerMetals still remained unchanged after storage of more than 12 months. They were only covered with rust deposit. Even peak-to-valley heights from previous treatments could clearly be recognised. There was no contact corrosion, not even at the transitional point of the PolymerMetal and the cast iron. It was proved that PolymerMetals are not electrically conductive and cannot constitute any local element with cast iron.

Tested PolymerMetals

MM-metal SS-steelceramic
MM-metal SS-steel 382
MM-metal SS-steel
MM-metal SQ
MM-metal oL-steelceramic
MM-metal UW
Ceranium®
MM-metal S-steel

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Worldwide repairs carried out with PolymerMetall® in the energy sector

(Photographs incl. descriptions of each repair can be found
on our website www.polymermetal.com, „Worldwide repairs“, REP-number)

REP-#	Description
002	Sealing of an oil leak between the cover and diverter switch of a transformer with MM-Elastomer 95. First the oil in the transformer was drained and the surface thoroughly cleaned with MM-Degreaser Z. Finally MM-Elastomer 95 was applied using a brush.
008	A leakage on a transformer (240.000 kVA) was repaired with MM-metal oL-steelceramic and Hardener red without cutting of the station. After this a second layer with MM-metal oL-steelceramic and Hardener yellow was applied.
018	Oil leakages of large transformers using MM-metal oL-steelceramic, Hardener red and Hardener yellow have been sealed.
039	Oil flew trough a crack at the cable terminal funnel of a block transformer. The repair was carried out by the method of direct-MM-bonding with MM-metal oL-steelceramic, Hardener red and Hardener yellow.
041	Sealing of a large transformer in a power station. The leakage was sealed with MM-metal oL-steelceramic and Hardener red using the direct-MM-bonding method. Then a layer of MM-metal oL-steelceramic and Hardener yellow was applied to the first layer.
042	The surface of a transformer between copper plates and fibreglass coating showed several oil leakages. The repair has been affected using the direct-MM-bonding method with MM-metal oL-steelceramic combined with Hardener red and Hardener yellow afterwards.
043	In a transformer station plant oil leakages at welding seams of a conservator were repaired with the direct-MM-bonding method by using MM-metal oL-steelceramic, Hardener red and Hardener yellow.
044	At the on-load tap changer of a large transformer oil was penetrating through cracks between the top and the on-load tap-changing equipment. The direct-MM-bonding method was used to solve this repair problem. It was carried out with MM-metal oL-steelceramic and Hardener red and afterwards Hardener yellow.
045	In order to avoid oil leakages at current transformers, the bolts were inserted with MM-metal oL-steelceramic and Hardener yellow.
047	Coating of welding seams on a large transformer with MM-metal oL-steelceramic and Hardener yellow.
099	A leakage in a 154 KV P.O.F. insulation pipe was sealed using MM-metal oL-steelceramic and Hardener red working with the direct-MM-bonding method. In addition corrosion damages of the piping were removed by applying MM-metal SS-steel, liquid and Hardener yellow, liquid. Oil pressure 200 psi, diameter of the piping 300 mm, oil quality polybdenum.
110	Sealing of leakages on large transformers using MM-metal oL-steelceramic and Hardener red.
114	Leakages between porcelain insulators and steel discs were sealed with MM-metal oL-steelceramic and Hardener yellow.
154	Oil exuded through micro cracks caused by vibration a defective welded seam. The leak of oil has amplified after unsuccessful attempt to execute repair by usual welding. Then it was decided to carry out a repair by using the "direct-MM-bonding"- technology with the help of MM-metal oL-steelceramic and hardener red followed by a second layer of MM-metal oL-steelceramic with hardener yellow.
155	Repair of a vertical crack in a welding in length of ~ 80 mm by using the repair technology "direct-MM-



bonding" with the help of MM-metal oL-steelceramic and the hardeners red and yellow.

- 156 The welding at 19 places of transformers had micro cracks and blowholes, where oil exuded. First the paint has been removed with an electro drill equipped with an abrasive tool and the metal has been cleaned at the defective areas. Then MM-metal oL-steelceramic with Hardener red and afterwards Hardener yellow was applied. After checking the tightness of the repaired areas the corresponding areas have been painted over again.
- 157 Elimination of a leak of oil in a welding using the PolymerMetal MM-metal oL-steelceramic with Hardener red and Hardener yellow.
- 158 Several worn areas of a steel plant's leaky power transformer have been sealed with MM-metal oL-steelceramic and Hardener yellow.
- 159 A damaged power transformer located in a steel plant has been repaired by using MM-metal oL-steelceramic and Hardener yellow.
- 166 The turbine in an important hydroelectric power plant in South America was repaired with Ceramium. A turbine shovel was damaged by effect of cavitation and erosion. In the turbine wheel there is a pressure of up to 12 bar and 700.000 litres water per second is moved. After 10 months of continuous operation a revision was carried out and merely low erosion and cavitation damages could be determined in the Ceramium coating which were not of further importance. 95% of the Ceramium coating was in good order.
- 169 In an approximately 8 m long pipe section of a fuel pipe situated in sea water (location Middle East) of a well known energy provider, a considerable wall thickness recession was detected by ultrasonic tests caused by corrosion and erosion. Prior to the decision of repairing the 16 inch (outer diameter) big piping, a pre-test was carried out. Here MM-metal UW was used together with fabric tapes made of glass fibre. The above photographs show the corresponding test application of a slightly slimmer pipe. After the good test results the actual pipe (16 inch outer diameter, original wall thickness ~ 13 mm, wall thickness recession at thinnest spot to approx. 5 mm; in addition to that deep pittings; water temperature during application approx. 14 – 18 °C; operation pressure in pipe approx. 5,5 up to max. 10 bar) was also repaired later. In the end 100 units of MM-metal UW / Hardener UW were used for this operation. Here the pipe was prepared/machined (roughened) in the worn area. Then, under water, a first (base) coat was applied. Afterwards the fabric tapes were prepared – that means they were coated from both sides with the mixed MM-metal UW – and then wrapped around the pipe onto the still not cured base coating. For a good repair success it was important that the pot life was kept, that means the time which is available for processing the material.
- 176 For a long time MultiMetall's repair technology is used successfully in the energy sector for the elimination of various types of damages. Because of the advantages of the polymer metallic materials against conventional welding procedures particularly MM-metal oL-steelceramic is well-established for the repair of leaky transformers at notable transformer producers, operators and service companies. For metal specific problems and plenty damage variants in the energy sector MultiMetall offers a customised solution on a polymer-metallic basis. Further information about this field of application can be found here: www.metalexistence.com/transformer

MultiMetall

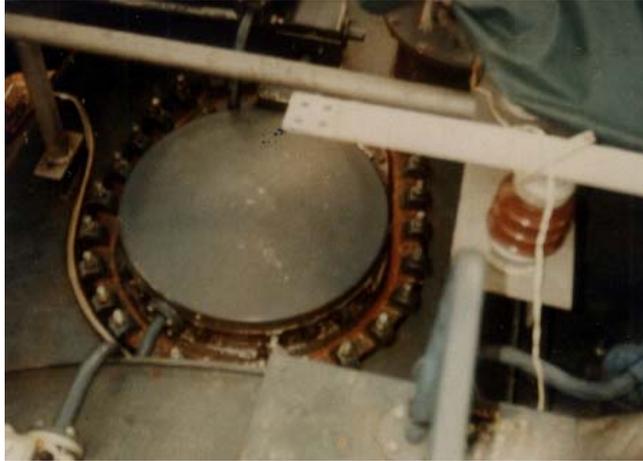
the MetalExistenceCompany®

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Worldwide repairs carried out with PolymerMetall®

REP-# 044



At the on-load tap changer of a large transformer oil was penetrating through cracks between the top and the on-load tap-changing equipment. The direct-MM-bonding method was used to solve this repair problem. It was carried out with MM-metal oL-steelceramic and Hardener red and afterwards Hardener yellow.

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Worldwide repairs carried out with PolymerMetal®

REP-# 099



A leakage in a 154 KV P.O.F. insulation pipe was sealed using MM-metal oL-steelceramic and Hardener red working with the direct-MM-bonding method. In addition corrosion damages of the piping were removed by applying MM-metal SS-steel, liquid and Hardener yellow, liquid. Oil pressure 200 psi, diameter of the piping 300 mm, oil quality polybdenum.

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REP-#154



Oil exuded through micro cracks caused by vibration in a defective welded seam. The leak of oil has amplified after unsuccessful attempt to execute repair by usual welding. Then it was decided to carry out a repair by using the "direct-MM-bonding"- technology with the help of MM-metal oL-steelceramic and hardener red followed by a second layer of MM-metal oL-steelceramic with hardener yellow.

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Worldwide repairs carried out with PolymerMetal®

REP-#155



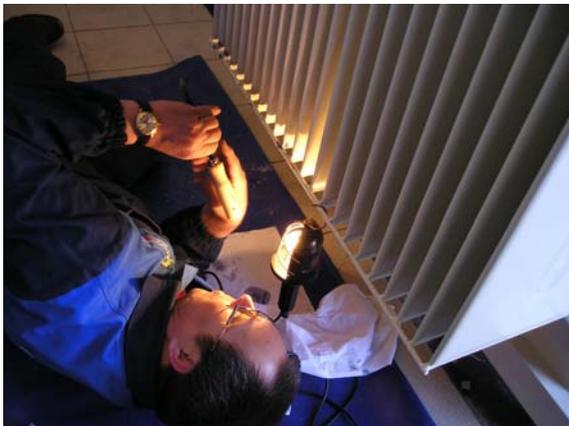
Repair of a vertical crack in a welding in length of ~ 80 mm by using the repair technology “direct-MM-bonding” with the help of MM-metal oL-steelceramic and the hardeners red and yellow.

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Worldwide repairs carried out with PolymerMetal®

REP-#156



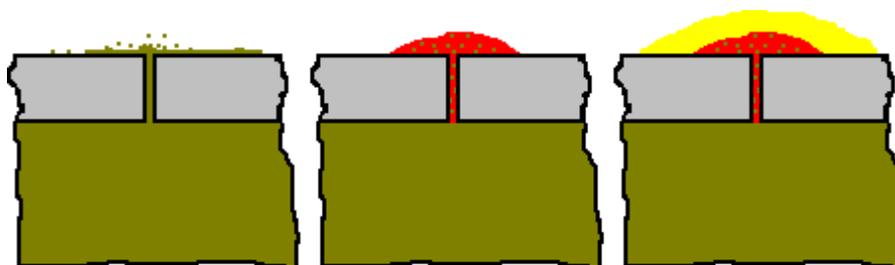
The welding at 19 places of transformers had micro cracks and blowholes, where oil exuded. First the paint has been removed with an electro drill equipped with an abrasive tool and the metal has been cleaned at the defective areas. Then MM-metal oL-steelceramic with Hardener red and afterwards Hardener yellow was applied. After checking the tightness of the repaired areas the corresponding areas have been painted over again.

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Worldwide repairs carried out with PolymerMetal®

REP-#157



- Öl
- MM-metal oL-Steelceramic mit Härter rot
- MM-metal oL-Steelceramic mit Härter gelb

Elimination of a leak of oil in a welding using the PolymerMetal MM-metal oL-steelceramic with Hardener red and Hardener yellow.

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Worldwide repairs carried out with PolymerMetal®

REP-#158



Several worn areas of a steel plant's leaky power transformer have been sealed with MM-metal oL-steelceramic and Hardener yellow.

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Worldwide repairs carried out with PolymerMetal®

REP-#159



A damaged power transformer located in a steel plant has been repaired by using MM-metal oL-steelceramic and Hardener yellow.

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Produktübersicht / Product Overview

Prod-#	Produkt (Deutsch / German)	Product (Englisch / English)	Einheit/Unit	Notizen/Notes
	MM-metall SS-StahlKeramik	MM-metal SS-steelceramic		
200	MM-metall SS-StahlKeramik, pst.	MM-metal SS-steelceramic, pst.	1000 g	
249	Härter gelb, pst.	Hardener yellow, pst.	50 g	
248	Härter rot, pst.	Hardener red, pst.	100 g	
	MM-metall SQ	MM-metal SQ		
300	MM-metall SQ, pul.	MM-metal SQ, pow.	1000 g	
301	Härter SQ2, fl.	Hardener SQ2, liq.	220 g	
302	Härter SQ8, fl.	Hardener SQ8, liq.	220 g	
	MM-metall SS-Stahl 382	MM-metal SS-steel 382		
217	MM-metall SS-Stahl 382, pst.	MM-metal SS-steel 382, pst.	1000 g	
249	Härter gelb, pst.	Hardener yellow, pst.	50 g	
218	MM-metall SS-Stahl 382, fl.	MM-metal SS-steel 382, liq.	1000 g	
250	Härter gelb, fl.	Hardener yellow, liq.	50 g	
	MM-metall SS, pastöse Konsistenz	MM-metal SS, pasty consistency		
201	MM-metall SS-Stahl, pst.	MM-metal SS-steel, pst.	1000 g	
205	MM-metall SS-Aluminium, pst.	MM-metal SS-aluminium, pst.	600 g	
209	MM-metall SS-Kupfer, pst.	MM-metal SS-copper, pst.	1000 g	
211	MM-metall SS-Bronze, pst.	MM-metal SS-bronze, pst.	1000 g	
249	Härter gelb, pst.	Hardener yellow, pst.	50 g	
	MM-metall SS, flüssige Konsistenz	MM-metal SS, liquid consistency		
202	MM-metall SS-Stahl, fl.	MM-metal SS-steel, liq.	1000 g	
206	MM-metall SS-Aluminium, fl.	MM-metal SS-aluminium, liq.	600 g	
210	MM-metall SS-Kupfer, fl.	MM-metal SS-copper, liq.	1000 g	
212	MM-metall SS-Bronze, fl.	MM-metal SS-bronze, liq.	1000 g	
250	Härter gelb, fl.	Hardener yellow, liq.	50 g	
	MM-metall oL-StahlKeramik	MM-metal oL-steelceramic		
2460	MM-metall oL-StahlKeramik, pst.	MM-metal oL-steelceramic, pst.	1000 g	
249	Härter gelb, pst.	Hardener yellow, pst.	50 g	
248	Härter rot, pst.	Hardener red, pst.	100 g	
246	MM-metall oL-StahlKeramik, pst.	MM-metal oL-steelceramic, pst.	500 g	
253	Härter gelb, pst.	Hardener yellow, pst.	25 g	
248	Härter rot, pst.	Hardener red, pst.	100 g	
	MM-metall UW	MM-metal UW		
1160	MM-metall UW, pul.	MM-metal UW, pow.	1000 g	
1170	Härter UW3, fl.	Hardener UW3, liq.	250 g	
1180	Härter UW9, fl.	Hardener UW9, liq.	250 g	
116	MM-metall UW, pul.	MM-metal UW, pow.	500 g	
117	Härter UW3, fl.	Hardener UW3, liq.	125 g	
118	Härter UW9, fl.	Hardener UW9, liq.	125 g	
	Ceranium®	Ceranium®		
601	Ceranium, pst.	Ceranium, pst.	695 g	
611	Härter CE, pst.	Hardener CE, pst.	55 g	
602	Ceranium, fl.	Ceranium, liq.	695 g	
607	Härter CE, fl.	Hardener CE, liq.	55 g	
	Ceranium® CH	Ceranium® CH		
622	Ceranium CH, pst.	Ceranium CH, pst.	1000 g	
623	Härter CH1, pst.	Hardener CH1, pst.	75 g	
624	Härter CH1, fl.	Hardener CH1, liq.	65 g	
625	Härter CH2, pst.	Hardener CH2, pst.	80 g	
626	Härter CH2, fl.	Hardener CH2, liq.	70 g	
	XETEX® BD	XETEX® BD		
455	XETEX BD, pst.	XETEX BD, pst.	750 g	
456	Härter BD, fl.	Hardener BD, liq.	50 g	

Produktübersicht / Product Overview

Prod-#	Produkt (Deutsch / German)	Product (Englisch / English)	Einheit/Unit	Notizen/Notes
	VP 10-017	VP 10-017		
705	VP 10-017, fl.	VP 10-017, liq.	800 g	
706	Härter VP 10-017 rot, fl.	Hardener VP 10-017 red, liq.	400 g	
707	Härter VP 10-017 grau, fl.	Hardener VP 10-017 grey, liq.	400 g	
	VP 10-500	VP 10-500		
701	VP 10-500, pst.	VP 10-500, pst.	650 g	
711	Härter VP 10-500, pst.	Hardener VP 10-500, pst.	650 g	
702	VP 10-500, str.	VP 10-500, br.	650 g	
712	Härter VP 10-500, str.	Hardener VP 10-500, br.	650 g	
	Molymetall®	Molymetall®		
401	Molymetall, pst.	Molymetall, pst.	800 g	
403	Härter Molymetall, pst.	Hardener Molymetall, pst.	30 g	
404	Härter Molymetall, fl.	Hardener Molymetall, liq.	30 g	
	Sealium®	Sealium®		
551	Sealium, fl.	Sealium, liq.	2000 ml	
	MM-metall S	MM-metal S		
101	MM-metall S-Stahl, pul.	MM-metal S-steel, pow.	1000 g	
102	MM-metall S-Eisen, pul.	MM-metal S-iron, pow.	1000 g	
105	MM-metall S-Aluminium, pul.	MM-metal S-aluminium, pow.	650 g	
108	MM-metall S-Kupfer, pul.	MM-metal S-copper, pow.	1650 g	
109	MM-metall S-Bronze, pul.	MM-metal S-bronze, pow.	1650 g	
147	Härter S8, fl.	Hardener S8, liq.	250 g	
148	Härter S15, fl.	Hardener S15, liq.	250 g	
	MM-Elastomer	MM-Elastomer		
951	MM-Elastomer 95, pst.	MM-Elastomer 95, pst.	370 g	
952	MM-Elastomer 95, fl.	MM-Elastomer 95, liq.	370 g	
953	MM-Elastomer 95, str.	MM-Elastomer 95, br.	370 g	
962	Härter EL95, fl.	Hardener EL95, liq.	110 g	
956	MM-Elastomer 85, fl.	MM-Elastomer 85, liq.	370 g	
964	Härter EL85, fl.	Hardener EL85, liq.	110 g	
958	MM-Elastomer 65, fl.	MM-Elastomer 65, liq.	370 g	
966	Härter EL65, fl.	Hardener EL65, liq.	74 g	
960	MM-Elastomer 40, fl.	MM-Elastomer 40, liq.	370 g	
968	Härter EL40, fl.	Hardener EL40, liq.	89 g	
	MM-Sets	MM-Sets		
802	MM-Basic Set	MM-Basic Set	Stück / pc	
803	MM-Set SS	MM-Set SS	Stück / pc	
804	MM-Set oL	MM-Set oL	Stück / pc	
805	MM-Set UW	MM-Set UW	Stück / pc	
806	MM-Set VP 10-500	MM-Set VP 10-500	Stück / pc	
	Zubehör	Accessories		
10	MM-Lösung Z, fl.	MM-Degreaser Z, liq.	1000 ml	
11	MM-Lösung Z, fl.	MM-Degreaser Z, liq.	250 ml	
14	MM-Trennmittel, fl.	MM-Release agent, liq.	100 ml	
33	Mischplatte (Kunststoff)	Mixing plate (synthetic material)	20 x 12 cm	
16	Mischstab (rostfreier Stahl)	Mixing stick (stainless steel)	Stück / pc	
15	Mischbecher (Kunststoff)	Mixing cup (synthetic material)	Stück / pc	
25	Messlöffel rot	Measuring spoon red	Satz / set	
26	Messlöffel gelb	Measuring spoon yellow	Satz / set	
29	Messlöffel VP 10-500	Measuring spoon VP 10-500	Satz / set	
18	Gewebeband (rostfreier Stahl)	Fabric tape (stainless steel)	100 x 10 cm	
20	Gewebeband (Glasfaser)	Fabric tape (glass fibre)	1000 x 5 cm	
22	Gewebematte (Glasfaser)	Fabric mat (glass fibre)	30 x 40 cm	
23	Applikationsroller	Application roller	Stück / pc	
34	Temperaturindikator (Einweg)	Temperature indicator (one-way)	15 Stück / pc	

Hinweise / Notes:

Konsistenz/consistency: pst./pst.=pastös/pasty; fl./liq.=flüssig/liquid; pul./pow.=pulvrig/powdery; str./br.=streichbar/brushable

EXW = Lieferung ab Lager Deutschland excl. Verpackung / delivery ex works stock Germany excl. packing

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Web: www.polymermetal.com

Version (20.11.2013)

In order to find out which PolymerMetall® could be used to solve your repair problem we would like to ask you to fill in and send back this form. Additional sketches, drawings, photographs etc. could be helpful. We thank you for your effort!

Description of the device

Machine/Plant/Construction:

Damaged device (Name):

Function:

Material of the device:

Relevant dimensions (e.g. length, width, height, diameter, wall thickness...):
of the device:

of the damaged area:

Damage description (e.g. crack, wear, leakage,... – in detail please):
.....
.....
.....

Reason and cause of damage (Why?... Whereby?... – in detail please):
.....
.....

Constructive weakening (structural/mechanical strength) of the device due to damage
 No | Yes

Notes/Other:

Influences on the repair area at operating conditions

Thermal stress
min °C | max °C | Durable Ø °C

Mechanical stress
 No | Yes MPa | Yes

Pressure load by fluids
 No | Yes bar | Yes.....

Chemical stress
 No | Yes Chemical(s) (if so with concentration data) Chemical temperature
..... °C
..... °C
..... °C

Tribological stress

<input type="checkbox"/> No <input type="checkbox"/> Yes  Sliding wear (Adhesion) <input type="checkbox"/> Yes  Sliding abrasion (Abrasion) <input type="checkbox"/> Yes  Particle erosion – fluids (Erosion, Abrasion)	<input type="checkbox"/> Yes  Impact particle wear (Abrasion) <input type="checkbox"/> Yes  Drop erosion wear (Surface fatigue) <input type="checkbox"/> Yes  Cavitation wear (Surface fatigue)
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