

Chemfilm of Aluminum

By Phil Marsh, M.E. Solutions, San Diego, CA
Kevin Hardy, DeepSea Power & Light, San Diego, CA

Chromate conversion coating is a widely used "plating" process for corrosion protection of aluminum and aluminum alloys. "Chemfilm," or "chemical conversion coating" as the military likes to call it, is also widely known by the brand names Alodine and Iridite. All government and most commercial engineering drawings specify chemfilm using the military standard MIL-DTL-5541F, 11 July 2006 (SUPERSEDING MIL-DTL-5541FE 30 November 1990 "CHEMICAL CONVERSION COATINGS ON ALUMINUM AND ALUMINUM ALLOYS,"), Type I or II, Class 1A, or Class 3.

Chemfilm is a water dilute solution that coats a chromium gel on the aluminum surface to form a surface corrosion resistant film when dried. Type I contains hexavalent chromium, Type II does not. Hexavalent chromium is highly toxic, and Type II alternatives are being advanced under RoHS.

Class 1A is intended to provide corrosion prevention on unpainted items as well as improve adhesion of paint finish systems. Class 1A may be used on tanks, tubing, and structures without paint, or where paint may be applied to one surface only. In underwater applications using chemfilmed 6061-T6 Al, the additional use of a sacrificial zinc anodes aides in corrosion control. (See Fig. 1.)

Class 3 is intended for use as a corrosion preventive film for electrical and electronic applications where low resistance surface contact is important, such as EMI shielding for electronics modules.

The primary difference between a Class 1A and a Class 3 coating is thickness. Coating thickness is varied by immersion time, from 1 to 6 minutes, and as a result, the same conversion material can be listed for both classes. Because Class 3 coatings are thinner they are more susceptible to corrosion than Class 1A coatings. If it is required to paint areas surrounding electrical contacts, Class 3 coatings improve adhesion of paint systems. In either case, the thickness build-up is so slight that no significant dimensional change is measured, and machine shop allowances required for other processes, such as hard anodize, are not needed with chemfilm. Chemfilm does not have appreciable abrasion resistance, however, and will scratch easily. Mechanical sealing surfaces must be assembled with care to avoid damaging the finish.

Chemfilm is usually specified either "clear," meaning no color, or "yellow" or "gold," meaning it appears as some shade of gold in color.

Bare aluminum, without any surface corrosion (oxidation), is a very good electrical conductor. As the surface oxidizes, the surface conductivity diminishes as if it were being anodized. The purpose of chemfilm is to minimize the surface oxidation. Of the two classes of chemfilm, Class 1A provides the maximum corrosion protection with the highest electrical surface resistance. Class 3 has lower corrosion protection in order to attain a low electrical surface resistance and is primarily used to electrically bond two touching metal surfaces together to form an EMI tight enclosure.

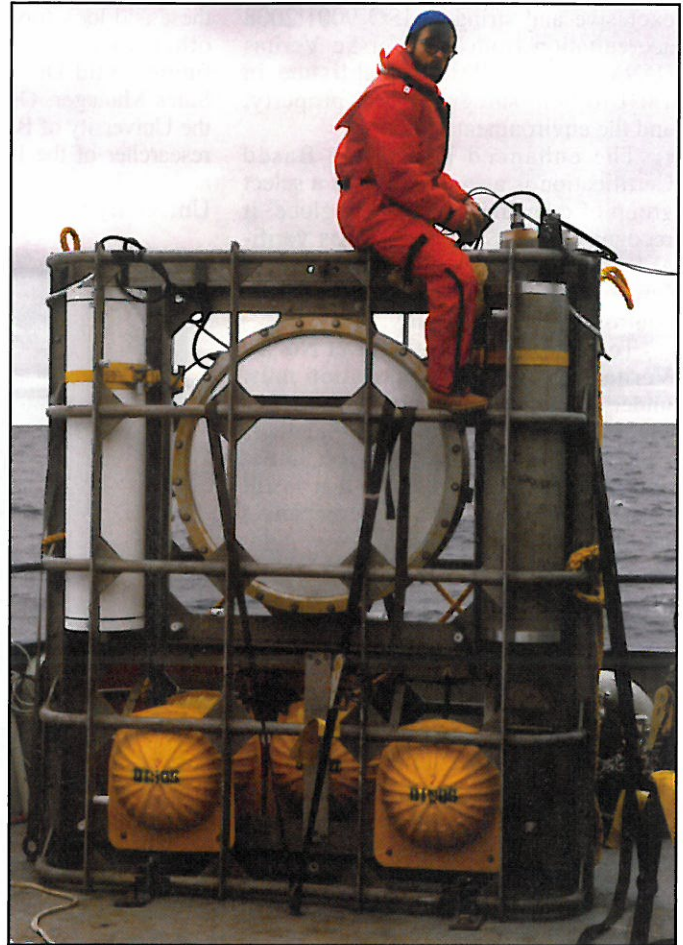


Fig. 1: A low frequency acoustic transceiver designed and built at Scripps Institution of Oceanography/UCSD, is seen on-board the Woods Hole Oceanographic Institution's R/V Knorr in October 1988 in the Greenland Sea. WHOI EE Steve Liberatore straddles the equipment cage, testing scientific equipment prior to launch. The cage is welded and heat treated 6061-T6, without any surface conversion coating, but protected by sacrificial zinc anodes. A vertical 6061-T6 Al cylinder to the left is hard anodized and painted white. A vertical cylinder to the right is chemfilmed except for the plug and bore, which are anodized for scratch resistance. The circular acoustic sound source in the center, made by HydroAcoustics (Rochester, NY) has an anodized and painted aluminum dome surface, while the retaining ring and housing are chemfilmed. The system survived a year long deployment without problem, and was used for several additional long term deployments."

Cleaning prior to applying the chemfilm coat is important. The base metal can be mechanically or chemically cleaned. Abrasives and cleaners to be avoided contain iron, such as steel wool, iron oxide, rouge, steel wire wheels or wire brushes, as they will contaminate the surface layer of the aluminum and later become galvanic corrosion cells.

Chemfilm is a non-electrolytic process, and may be applied by spray, brush, or immersion after all heat treatments and mechanical operations such as forming, perforating, machining, brazing, and welding have

been completed. This applies to touch-ups as well, a nice feature of chemfilm, though the MilSpec limits the touch up area to 5% of the part surface area.

MIL-DTL-5541F specifies process control and conformance inspection criteria, including test specimens, and solution analysis to assure a Class 1A or Class 3 coating. The designer's specification to the plater should state the test that is most appropriate to the end purpose: color, salt spray resistance, paint adhesion, or electrical surface resistance. The MilSpec discusses these in detail.

A good visual approximation of proper coating is the tint of the gold color coating. Class 1A are usually dark gold to a yellowish brown, where as Class 3 coatings are very light gold or amber color. Clear coatings should be avoided since it provides no visual indication there is a coating at all on the part. MIL-DTL-5541F uses colored chemfilm as the default, stating that "Clear (colorless) coating shall only be used when specifically authorized by the procuring activity."

The low electrical resistance test for Class 3 chemfilm is easily overlooked in favor of a simple visual color check, but if surface resistivity is critical, testing that parameter directly is the best means to assure intended design goals are met.

Finally, go out of your way to communicate your intentions to your plater, showing on your drawing or attached specification the following details:

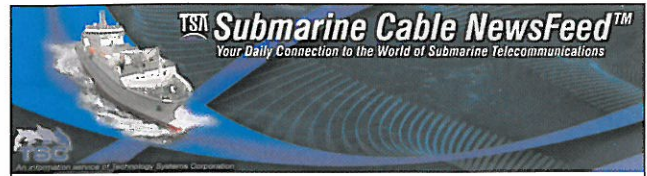
- a. Title, number, and date of the specification, currently "MIL-DTL-5541F, 11 July 2006".
- b. Type and class required, Type I or II, and Class 1A or 3
- c. Method of application (immersion, spray, or brush)
- d. If touch-up is permitted for mechanically damaged areas.
- e. Colorless coatings, if required
- f. If touch-up is permitted for contact marks.
- g. Omit the paint adhesion test, if permitted.
- h. If electrical resistance testing is required for class 3 coatings. (Yes/No)
- i. When electrical resistance testing is required, specify the required resistance values, frequency of testing, and test method.
- j. Alloy and temper of the material.
- k. Paint finish system for treated parts, if applicable.
- l. Quantity required.
- m. Sampling plan, if different than that specified.
- n. Lot size, if different than that specified

Designers can also state on their drawing that all processes are to be by commercial standards to reduce cost, but results may vary. When it matters, be specific.

Alodine is a trademark of Henkel Surface Technologies.

Irridite 14-2 is a proprietary name of a whole family of conversion coatings by MacDermid.
Copyright 2009

For a complete list of references, please contact Phil Marsh, M.E. Solutions <phil@mesolutionshome.com>, or Kevin Hardy, DeepSea Power & Light <kevin_hardy@deepsea.com>



Submarine Telecom Cable Industry

Daily News

When it happens

Who What Where

Receive comprehensive, up-to-date, relevant coverage that provides fast access to the information you need in today's business environment.

Subscribe Today!

www.subcableworld.com

ROV SERVICES
SUBMERSIBLE SYSTEMS INC.
885-395-0933

**Superior Through Flow
Ultra-High Thrust
Easy to Fly
Rugged
Compact
Modular**

Just the beginning...

**See more on the
TRV-005
The Ultimate in
ROV Performance**

www.ssirovs.com

News for the Ocean Industry
Ocean

www.ocean-news.com
News
& **Technology**

July/August 2009

Investigating Deepwater Reefs, Rigs and Wrecks — Biodiversity Hotspots

Salazar Approves Five Offshore Wind Energy Exploratory Leases

First of its kind ever issued by the
U.S. Federal government

Obama Launches Ocean Task Force

Memorandum calls for Inter-agency task
force to create a national ocean policy

Weak Gas Markets Delay Recovery

Report suggests a weakness in global
natural gas markets will delay a recovery
in U.S. gas prices and rig counts

EnergyOcean 2009 a Success

EnergyOcean, the world's leading conference
on renewable ocean energy, sees a 90%
attendance increase over last year



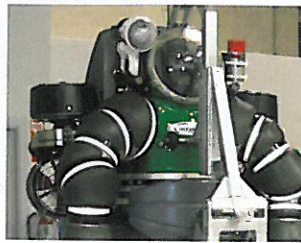
"United We Stand"



21



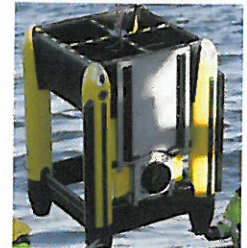
44



50



57



60

REGULAR FEATURES

- 10 Ocean Briefs
- 16 Ocean Energy
- 22 Ocean Science
- 28 Offshore Industry
- 40 Defense
- 46 Conference News
- 48 Underwater Intervention
- 52 Ocean Engineering 101
- 56 Product News

DEPARTMENTS

- 64 Media Reviews
 - 65 tech note
 - 66 People & Company News
 - 73 Calendar
 - 74 Ocean Industry Directory
- 6 Volume 15 • Issue 5

In the Next Issue...

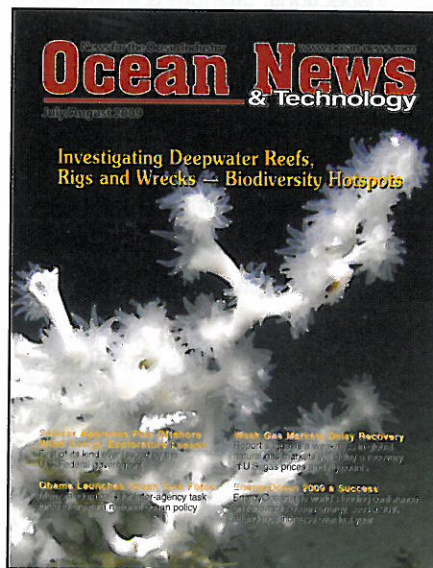
Editorial Focus

- *Oceanography & Meteorology*
- *Maritime Security*

COVER STORY

38 TDI-Brooks International, Inc.

Investigating Deepwater Reefs, Rigs and Wrecks — Biodiversity Hotspots



EDITORIAL

8 Finders Keepers

How GE Oil and Gas attract and retain the best and most experienced employees

PRODUCT REVIEW

30 The Guardian Diver Mask

COMPANY SPOTLIGHT

26 RESON

54 Sonatech

ADVISORY BOARD

DR. JOHN PINA CRAVEN
Honolulu, Hawaii

PHILIPPE PIERRE COUSTEAU
Washington, D.C.

DR. PHIL HART
Pennington, New Jersey

KEVIN HARDY
San Diego, California

EDWARD CARGILE
Oceanside, California

DAN & PEGGY WHITE SR.
Tampa, Florida