**INTERNATIONAL LEAD ZINC RESEARCH ORGANIZATION, INC.**

GALFAN TECHNICAL RESOURCE CENTER

2525 MERIDIAN PARKWAY
POST OFFICE BOX 12036
RESEARCH TRIANGLE PARK, N.C. 27709-2036
TELEPHONE 361-4647 (AREA CODE 919)
TELEX: 261533
FACSIMILE: (919) 361-1957

# MEMORANDUM

TO: GALFAN Wire Licensees
GALFAN Technical Resource Center Sponsors
GALFAN Alloy Licensees
GALFAN Suppliers
Dr. Richard F. Lynch, ILZRO Consultant
Dr. D. Coutsouradis, CRM

FROM: Marshall P. Roman, Director MPR
GALFAN Technical Resource Center

DATE: 5 September 1989

SUBJECT: Minutes of the Fourth GALFAN Wire Licensees Meeting
7 July 1989, Helsinki, Finland

---

Enclosed are the subject minutes. Please note that in 1988, approximately 10,500 tons of GALFAN wire were produced. Estimated 1989 tonnage is approximately 11,500 tons. Production figures for Indiana Steel & Wire and Kawatetsu Wire Products Co., Ltd. are not included, since their production plans are not yet totally established.

The 1990 Licensee Meeting will be held in Liege, Belgium, at the Holiday Inn-Palais des Congres during the week of 4-8 June 1990. Final details will be sent to all GALFAN Licensees at a later date.

MPR/ja

Encls.

**INTERNATIONAL LEAD ZINC RESEARCH ORGANIZATION, INC.**

GALFAN TECHNICAL RESOURCE CENTER

2525 MERIDIAN PARKWAY
POST OFFICE BOX 12036
RESEARCH TRIANGLE PARK, N.C. 27709-2036
TELEPHONE 361-4647 (AREA CODE 919)
TELEX: 261533
FACSIMILE: (919) 361-1957

# Minutes of the Fourth GALFAN Wire and Tube Licensees Meeting
July 7, 1989

Hotel Hesperia
Helsinki, Finland

## ATTENDANCE:

| Name | Company |
|---|---|
| Bergaentzle, D. | TrefilUNION |
| Coutsouradis, D. | C.R.M., Liege, Belgium |
| DeWitte, M. | Bekaert |
| Goodwin, F. | ILZRO |
| Hubert, R. | ARBED |
| Lamberigts, M. | C.R.M., Liege, Belgium |
| Lanero, T. | Altos Hornos de Vizcaya (Spain) |
| Lynch, R. | ILZRO Consultant |
| McAuliffe, J. | ZALAS |
| Mine, K. | Kawatetsu Wire Products |
| Nunninghoff, R. | University of Wuppertal |
| Payne, D. | British Ropes Ltd. |
| Pierre, M. | Centre du Zinc, France |
| Rodellas, T. | PROCOAT SA |
| Roman, M. | ILZRO |
| Southern, J. | PASMINCO Europe Ltd. |
| Stoneman, A. | ZDA |
| Subramanian, V.R. | ILZIC |
| Tajiri, Y. | NKK Corp. |
| vanEijnsbergen, J.F.H. | Consultant Coating Technology |
| Wegria, J. | Vieille-Montagne |

## MEETING CONVENED:

Mr. Roman who chaired the meeting, welcomed all to Helsinki. He noted that most of the attendees present at this time had been present in the meeting the day before, and since most of the participants, if not all had already introduced themselves the previous day, he only circulated the attendance roster and moved right into the research presentation by CRM.

Mr. Roman reintroduced Mr. Lamberigts of CRM who presented the CRM research on wire.

GALFAN Licensees Meeting Minutes (contd.)
Wire & Tube Operations Session
July 7, 1989

CRM Research - GALFAN Wire:

Mr. Lamberigts presented the CRM work on wire research. The work is reproduced in the appendix to the minutes. The highlights are printed below. Mr. Lamberigts began by describing the wire exposure program, for exposure sites at Liege (industrial), and Oostende (marine). He was concerned with the effects of lead on corrosion resistance. Lead levels were up to and including 300 ppm. The GALFAN long-term exposure program included coatings with thicknesses ranging from 5 to 42 microns. Mr. Lamberigts noted that some galvanized was totally red rusted in three years, however there were some galvanized samples that appeared to have corroded less than the GALFAN wire. He felt that perhaps a three-year exposure term was not yet long enough to sufficiently come to a conclusion. The two-year program of exposure has wires at Eupen (rural), Liege, and Oostende. Mr. Lamberigts noted that he felt the exposure results on two years on straight wire to be the most significant, whereas twisted wire can confuse the issue. He did note that the inclusion of magnesium in the alloy composition appeared to be detrimental.

Dr. Goodwin interjected noting a reference to a study on general galvanizing by Mr. vanEijnsbergen where there appear to be two exposure results, a weathered side and a protected side. Again, this confirmed Mr. Lamberigts opinion that studies should be conducted on straight wire. Dr. deWitte also specified the need for caution when referring to the percent aluminum in GALFAN coatings on wire. In the double dip process the alloy layer can be up to 20 to 25% aluminum which will affect the total chemistry outlook. Dr. Goodwin also noted that, in reference to a British Ropes request for the short-term effects of lead (Pb) on GALFAN performance (for GALFAN on fishing boats), short term corrosion is not a problem. The problem is erosion, so there was a need for relevance in the short term of exposure (the ropes wear out by erosion before they wear out by corrosion). Derek Payne of British Ropes confirmed that by noting that GALFAN fishing ropes last two years, whereas galvanized fishing ropes last one year (Mr. Lamberigts continued his presentation on GALFAN wire by starting an analysis of industrial wire submitted by Mr. Roman several months previously). Mr. Lamberigts continued by noting that the GALFAN wire performed very well. It had excellent salt spray resistance, excellent ductility. The only observed problem was a lack of concentricity, whereas sometimes the minimum and maximum thicknesses were a ratio of 2 to 1, or 1 to 2.

Mr. Roman noted that the producer of the wire indicated that the cause of non-concentricity had nothing to do with the GALFAN process itself. An area of the process where the wire is turned over turn-down rolls is where the alloy may still have been soft and deformed. Dr. Goodwin added a question of are there any existing concentricity standards for wire? Mr. Payne responded that he only knows of the Preece test to check thin spots of zinc coatings, but he felt the results presented here today were not unusual.

Dr. de Witte noted that salt spray tests on GALFAN and galvanized will look similar at first. It is only after a long time of actual outdoor exposure does the superiority of GALFAN become clear. He noted that it is his observation at Bekaert that the corrosion resistance of GALFAN appears to be parabolic, that is, the corrosion rate levels off rather than remaining linear as galvanized appears to do. Dr. deWitte noted that he is not surprised at the two-year exposure results. Mr. van Eijnsbergen asked if anyone present could quote a reliable ratio of corrosion resistance of GALFAN versus galvanized, that is, how much better is GALFAN than galvanized? Dr. deWitte said that he knows that GALFAN is better, but he still does not have final results to where he can specifically state such a ratio but it is his opinion that GALFAN, which is two to three times better performing in a laboratory, is a superior product. Dr. deWitte noted that in the Kesternich testing in the laboratory, GALFAN does not perform any better than galvanized. If you decreases the percentage of ppm of $SO_2$, GALFAN does perform much better than galvanized. Mr. John Southern asked if a parabolic curve relationship for the corrosion resistance of GALFAN has been confirmed on the sheet in long-term outdoor exposure. Dr. Coutsouradis noted that corrosion of galvanized appears to be linear and indications have been seen for the parabolic relationship noted for GALFAN. Dr. Goodwin added that in the initial CRM research, a dilute $SO_2$ exposure of three to five ppm sulfur dioxide ($SO_2$) exposure GALFAN did exhibit the parabolic relationship. Dr. Coutsouradis also noted that CRM is still evaluating the wire that Mr. Roman submitted with respect to microstructural behavior. Mr. vanEijnsbergen made a comment relating to galvanized sheet, noting that he has a feeling that magnesium is most active in the initial stages of corrosion resistance and its effect levels off later on. Dr. Goodwin added that magnesium initially passivates rather quickly. Dr. Lynch made a comment noting the benefit of the day's discussions and wanted to make clear the fact that GALFAN's corrosion resistance improves with time (remains the same while galvanized drops off, therefore the relative "improvement"). Dr. Goodwin stated that the micrographic studies are necessary to differentiate between the free alloy layer of GALFAN and any existing intermetallic layer. He added that with erosion, there is a continuous exposure of "fresh" magnesium, which then continues to suppress the deleterious effect of lead (apparently). Mr. vanEijnsbergen noted that such additions like that of magnesium or lithium can result in instant short-term results but they later drop off to that of the "norm" therefore initial results look good but after a while the material does not look unusual. Dr. Nunninghoff also cautioned the group that short-term results on small samples (1 meter in length) can be very deceptive. To obtain good results, one needs larger samples. He related that it has been his experience where weight gains have been observed on small samples in short-term tests, so a wider number of samples on larger pieces is recommended. Dr. Coutsouradis agreed with that statement, noting that perhaps a bigger sample base is necessary. Dr. Subramanian made a comment stating that it was practical and necessary to conduct the studies as presented today, but he expressed his opinion that there is a need for an understanding of the behavior of only the coating, be it pure zinc or GALFAN without taking into account the effects of the substrate. He noted that work should be done on basic capabilities of GALFAN. Dr. Hubert of Arbed noted that the experiences of real life and the behavior of material is often quite different than the behavior in simulation tests. Dr. Goodwin agreed, noting that there is a need to relate theory to real life experiences. Mr. vanEijnsbergen noted that perhaps there should be a study of the behavior at the interface of the alloy layer and the free GALFAN layer. John Southern made a comment noting that he didn't know if the preferred wire microstructure for GALFAN has been established yet. Dr. Goodwin noted that the above statement was true in that there are double dip and single dip GALFAN wires (two different processes resulting in at least two different microstructures). Dr. Coutsouradis noted that behavior is very different with double dip material due to the presence of intermetallic alloy layer, although that layer is very thin. Dr. Hubert noted that he had a question about the influence of cerium and lanthanum on the process and properties of double dip GALFAN material. Dr. deWitte noted that such an evaluation would be difficult. He noted little experience on such a study but he knows there is a need for the wettability for total coating and in his experience he did not want to eliminate cerium and lanthanum (mischmetal), i.e. he didn't want to take the risk of causing bare spots. Dr. Hubert noted that he understands the need for mischmetal for GALFAN sheet and single dip wire, but as for its necessity in double dip material, he was questioning this requirement (since the material is coming straight from a zinc bath). Dr. Goodwin noted that it is known that mischmetal reduces the surface energy of the GALFAN alloy which increases its wettability. It is known also to have a positive influence and does improve the corrosion resistance of zinc and zinc alloys. Dr. Coutsouradis also added that the ductility of zinc-aluminum alloys are improved by the addition of mischmetal. Dr. deWitte added that with regard to wire, wettability is very, very important. There is a severe requirement for total coating and no bare spots. He noted that bare spots on wire are more critically detrimental to the product than for sheet.

OPERATIONS Reports:

Bekaert Report:

Dr. deWitte presented some overhead slides relating Bekaert experience on outdoor exposure of GALFAN wire in several different aspects. The overheads are reproduced in the minutes appendix. There were pictures of animal cages, utilizing welded GALFAN wire mesh. The GALFAN was outperforming the galvanized in salt spray and also one and one-half years outdoor exposure. Dr. deWitte also showed some pictures of Bekaert wire used in stranded cables for Italian fishing vessels. 110 g/m$^2$ GALFAN was compared to 200 g/m$^2$ galvanized wire. After one year, GALFAN appeared to be in very good condition, whereas the galvanized rope was red rusted. Cross-sectional microstructures of the fishing rope showed that the only breakdown of GALFAN was due to erosion whereas the galvanized rope was severely pitted and corroded. Dr. Goodwin noted that the salinity of the Mediterranean Sea was higher that that of the Atlantic Ocean, therefore it is a much more severe exposure that Dr. deWitte was highlighting.

Dr. deWitte continued by showing Bekaert's capacity and tonnage for GALFAN wire. Currently there is a capacity for 7,000 tons per year of wire diameters 1.5 to 6.5 mm. Dr. deWitte highlighted the GALFAN production at Bekaert. In 1986 there were 200 tons, 1987 there were 2,500 tons, in 1988 3,500 tons, and planned by 1995 to 7,000 tons (there should be 3,500 tons production in 1989).

Dr. Lynch noted that he knows of a new application for GALFAN relating to fatigue resistance offered by Bekaert. He asked if there was anything Dr. deWitte could say about it. Dr. deWitte noted that the photographs of such material were not ready for presentation.

Dr. Goodwin noted that he wondered if a sufficient amount of fatigue testing on GALFAN had been performed yet, and was there any need for more. He added that perhaps more studies on fatigue of GALFAN-coated wire may be needed. Dr. Coutsouradis noted to Dr. Nunninghoff that he knows that there has been some initiation of studies on GALFAN wire fatigue testing and he wondered if there were any results which could be passed on. Dr. Nunninghoff noted that those results were not available or ready yet.

Kawatetsu Wire Products:

Dr. Mine made a presentation on Kawatetsu Wire's initial GALFAN trials. Copies of the presentation are in the minutes appendix. Dr. Mine covered the parameters and specifications of the new Kawatetsu GALFAN wire line as well as trial conditions. He also covered the expected applications for the Kawatetsu GALFAN wire. Most of the applications of GALFAN for Kawatetsu would be in high carbon wire, usually for stranded ropes or cables. Dr. Mine also showed pictures of some surface defects he had observed and asked for any comments or assistance regarding those pictures. One picture was of a spiral grooving. Dr. Mine noted that that wire was produced at 40 meters per minute. The group concurred that the problem may be due to possible vibration of the wire as it exits the bath. The other picture was of small surface cracks. Without further study, the group concluded that perhaps it was alloy burst due to steel surface quality problems, but that would have to be more thoroughly investigated, usually by cross-sectional microstructural studies.

Dr. Coutsouradis noted that he understood that Kawatetsu Wire is developing a single dip method for zinc-5% aluminum without the need for flux. Dr. Mine noted that all he could say was that said flux was proprietary at this time. Dr. Lynch asked if said flux was only a chemical flux or would it incorporate the electrofluxing method. Dr. Mine did say that it did not need the electrofluxing step.

Dr. Goodwin extended the discussion by raising the question on the use of GALFAN as reinforcing material in concrete. He said there is little experience on concrete exposure to GALFAN wire. Dr. deWitte noted that Bekaert conducted some tests and they were not happy with the results so far, due to alkaline reaction. There is obviously a need for chromation of the wire. Mr. Bergaentzle noted that he had heard of work by Bekaert on wire ties that are exposed to an alkaline environment. Dr. Goodwin noted that he knew that such material was chromated. Dr. deWitte added that another process was needed to efficiently and economically apply the chromate to the wire. Dr. Goodwin stated that such work on exposure to concrete was done on normal galvanized material and he was quite interested in the possibilities for such work with GALFAN. Dr. Coutsouradis raised the question to the group wondering if there was any commercial possibilities for GALFAN as a reinforcing material. Dr. Hubert noted that there is a concern about a possible fatigue problem for such an application. Dr. Lynch thought that GALFAN wire could be used for pre-stressed concrete reinforcement. Dr. Hubert noted that at this time an epoxy coated wire is very popular. Mr. vanEijnsbergen noted that there are many complaints about epoxy wire and he noted that galvanized rebar performs very well but he also added that concrete people do not like the extra cost of reinforcing steel, whether it is galvanized or not and they are likely to cut costs where ever possible and legal. Dr. Subramanian noted that in India there have been trials with high tensile reinforcing steel. He noted a big problem is hydrogen embrittlement, causing steel failure.

MARKETING:

Brailsford Wire Report:

Dr. Lynch made a presentation of "Sales and Marketing of GALFAN Wire," by Mr. Joe Hogan of Brailsford Wire in his behalf. The paper is reproduced in its entirety in the appendix.

A comment by Mr. Derek Payne of British Ropes was that wire manufacturers will promote coated wire where said manufacturer wants to sell the wire and in what quantities. Mr. Bergaentzle and Dr. deWitte agreed with that comment. As regards marketing, there is a need for an advantage to promote GALFAN. The technical merits of GALFAN are known but the marketing and sales merits are yet to be fully realized. Dr. Lynch noted that with the use of GALFAN wire, one may be able to achieve sales not previously realized plus there is the possibility of more profits by selling GALFAN. Mr. Roman asked if the experience in Japan was similar, directing the question to Dr. Mine of Kawatetsu Wire. Dr. Mine noted that in Japan, the product was demanded, that is, a better performing product with greater corrosion resistance was demanded specifically by NTT (Nippon Telephone and Telegraph) so that the manufacturers had to respond with superior material. NTT demands a fifteen-year non-maintenance material for their applications.

Tonnage Estimates:

Mr. Roman started a discussion asking each of the manufacturers to note their current production levels. Mr. Bergaentzle noted that Trefilunion is planning to produce 2,500-3,000 tons in 1989. Mr. Roman continued by moving on to Mr. Derek Payne of British Ropes, who noted that currently there is no production of GALFAN wire, however British Ropes is purchasing GALFAN wire and making it into stranded cable for resale. Mr. Payne noted that there is no time scale to initiate GALFAN production, but they do have plans to eventually do so. Mr. Roman moved on to Dr. Mine of Kawatetsu Wire, who related that right now production trials are in progress but by early to mid 1990 there should be a minimum of 300 tons per month of GALFAN wire produced (to start). Mr. Roman spoke on behalf of Indiana Steel & Wire, noting that perhaps 500 tons would be produced in 1989 and 1990 production should go into large-scale production. Dr. Lynch added that the 500 tons for 1989 would probably be applied to fencing, which is a new market for Indiana Steel & Wire. Indiana Steel & Wire is also exploring applications for GALFAN wire in the automotive markets.

Mr. Southern noted that assuming GALFAN achieves 10% of the total wire market, what kind of tonnage per year would that be? Mr. Southern added that he knows that 10% is much higher than current GALFAN production is now, but he noted that such a figure is possible and desirable. Dr. Coutsouradis noted that on a worldwide scale there are perhaps 10 million tons of galvanized wire produced per year, so therefore 10% of that (or 1 million tons) would be major tonnage. Such tonnage will not be achieved for several years but is certainly possible. Dr. Lynch noted that Indiana Steel & Wire is definitely trying to achieve a leadership position with regards to the competition. It is noted that (obviously confidentially within the group here) Indiana Steel & Wire would like to of course get a head start in the North American market. Mr. Southern noted that he would like to know how many of the wire companies present have supplied GALFAN wire samples to the automotive companies. It was concluded that Bekaert and Trefilunion had begun investigations with Ford and also there are contacts with Peugot and Renault. Mr. Bergaentzle noted that, to the best of his knowledge, each wire company has its own marketing strategy. Trefilunion is starting slowly and building in a slow deliberate manner. That was the general consensus of the company representatives present at the time that the market will be there but it is going to be built slowly.

<u>MEETING CONCLUDED:</u>

As many of the representatives there had travel plans and time was running out, Mr. Roman concluded the meeting by noting that the next meeting should also be in one year's time in conjunction with the next sheet meeting. Mr. Roman thanked everyone for their attendance and participation and concluded the meeting at 11:40 a.m.

MPR/ja

# GALFAN WIRE LONG TERM EXPOSURE PROGRAM

**Products:** Industrial Wires (BEKAERT & ARBED)

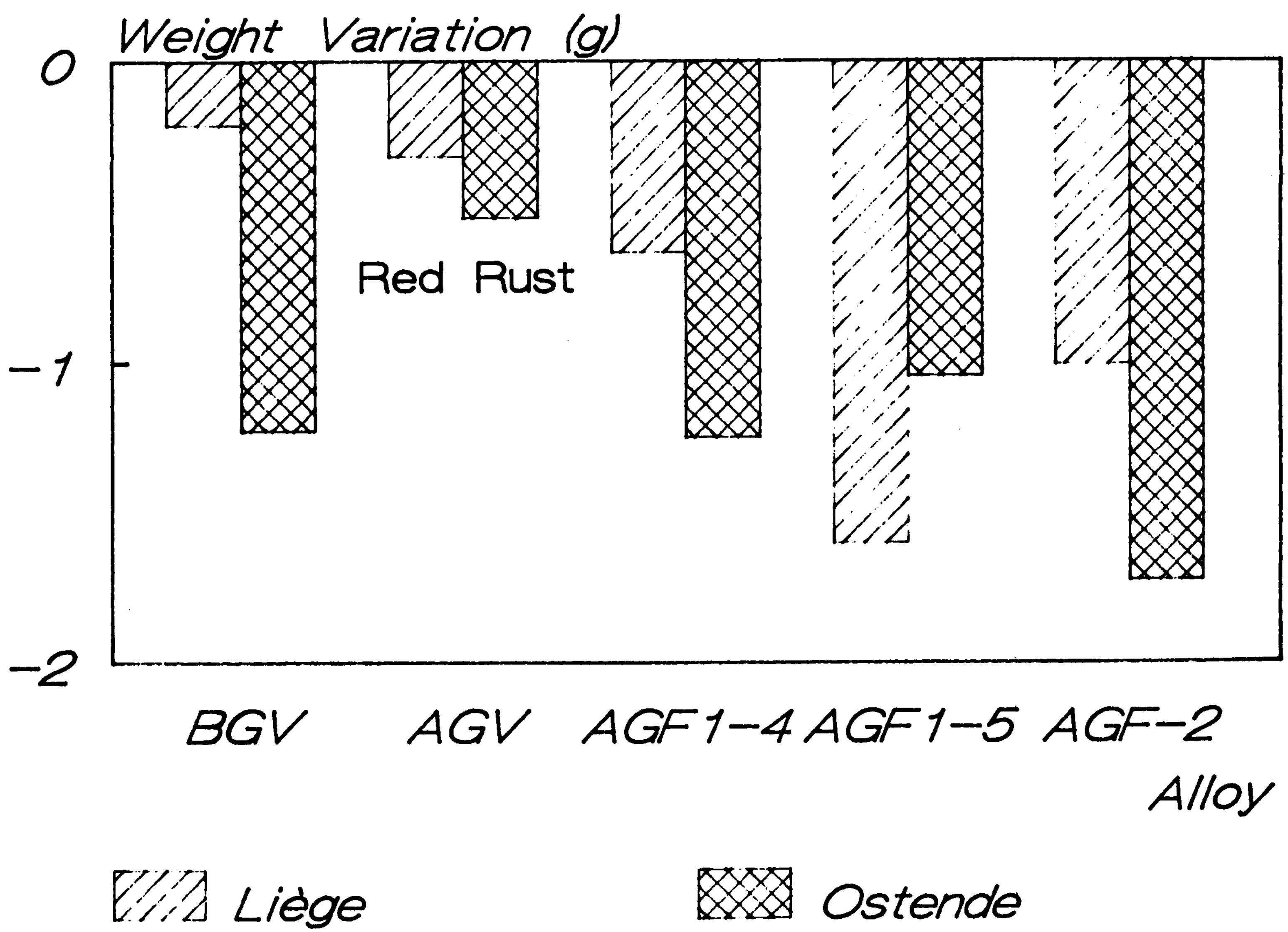
**Exposure sites:** Liège (Industrial) and Ostende (Marine)

| Origin | Coating | Wire diameter | Coating thick. |
|---|---|---|---|
| BEKAERT | Galvanised | 1.95mm | 42 microns |
| ARBED | Galvanised | 1.595mm | 5 microns |
| ARBED | Galfan (4%Al) | 2.442mm | 34 microns |
| ARBED | Galfan (5%Al) | 2.085mm | 44 microns |
| ARBED | Galfan (2 dips) | 1.945mm | 41 microns |

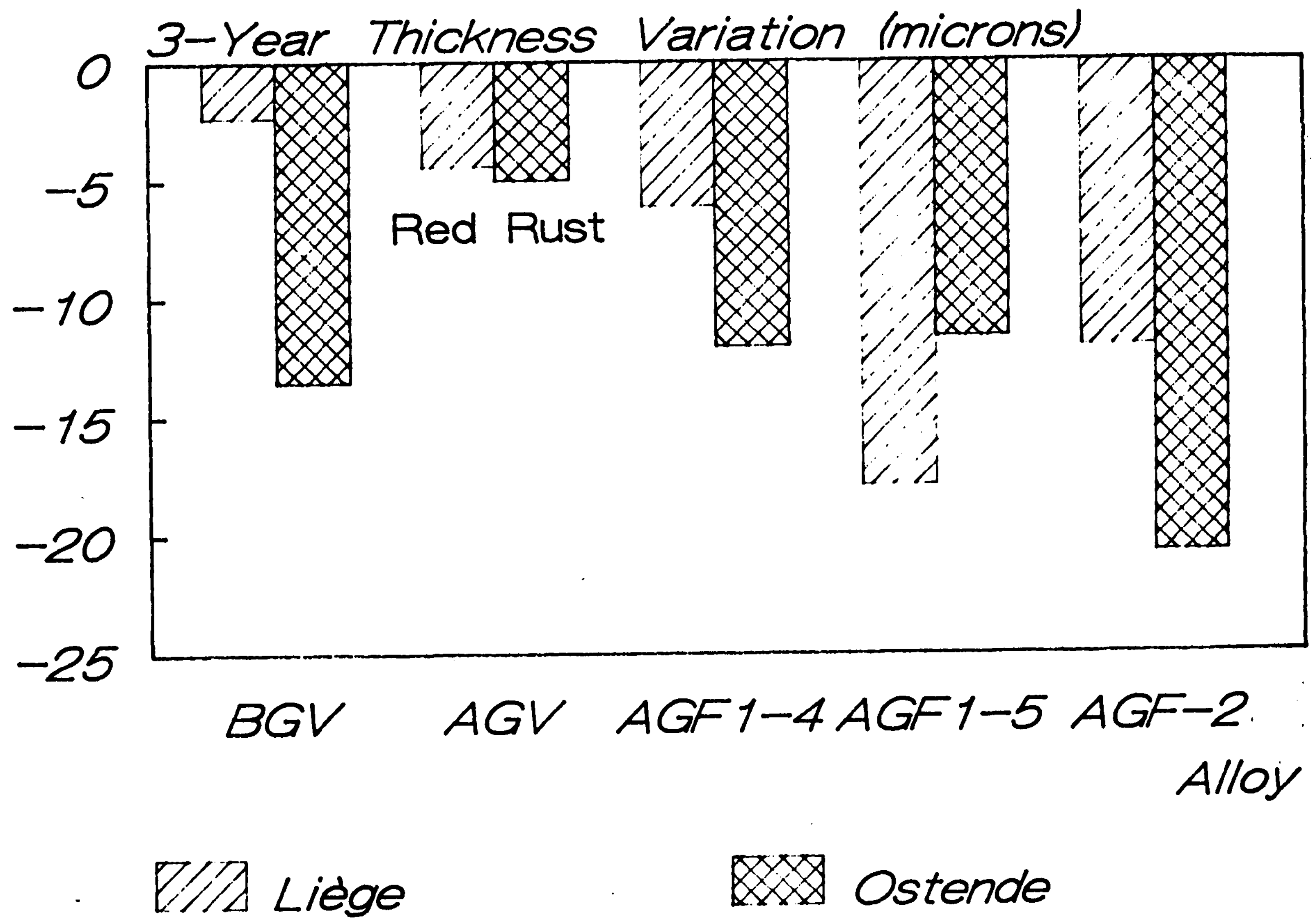
**Purpose:** –Effect of AL content on corrosion resistance
–Effect of Coating conditions (number of dips)

**Evaluation procedures:** Metallography
Weight loss

3-YEAR GALFAN WIRE EXPOSURE PROGRAM
Composition and Exposure Site



# 3-YEAR GALFAN WIRE EXPOSURE PROGRAM
## Composition and Exposure Site



# MINILINE GALFAN WIRES

## 3-Year Exposure Programme

| Alloy | %Al | %La-Ce | %Mg | Alloy density |
|---|---|---|---|---|
| GF | 5.2 | 0.02 | | 6.6 |
| GV-5-0 | 5 | | | 6.6 |
| GV-4-3 | 4.1 | | 0.05 | 6.69 |
| GF+50%Zk3 | 5 | 0.04 | 0.02 | 6.64 |

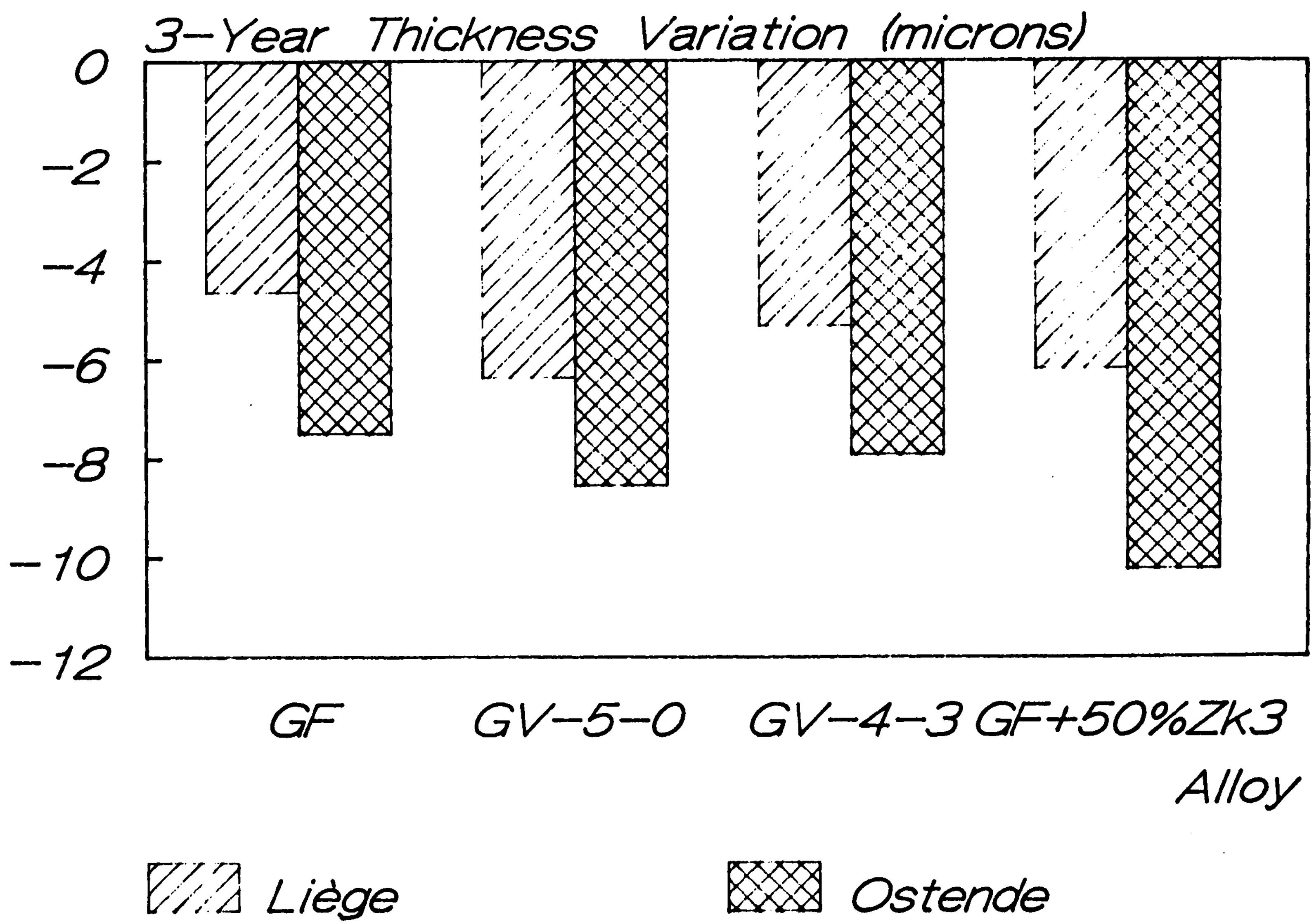
Variable Pb contents (between 50 & 300ppm)

Exposure sites: Liège (Industrial) & Ostende (Marine)

Purpose: Effects of Al and Pb contents on corrosion resistance

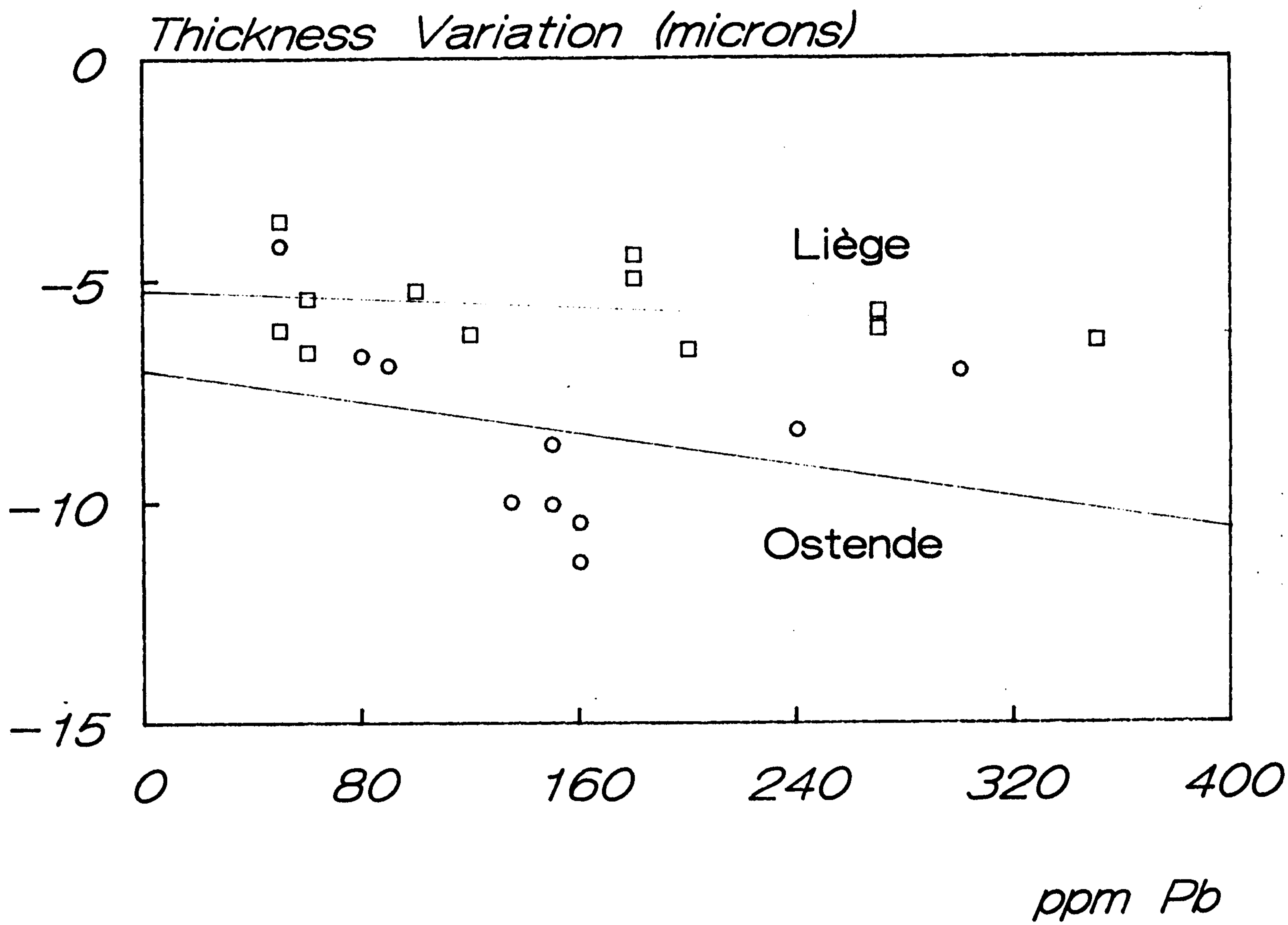
Evaluation procedure: Weight loss measurements

MINILINE GALFAN WIRE PROGRAMME
Al Content and Exposure Site



MINILINE GALFAN WIRE PROGRAMME

Pb Content and Exposure Site



# INDUSTRIAL WIRE EXPOSURE PROGRAMME

## 2–Year performance

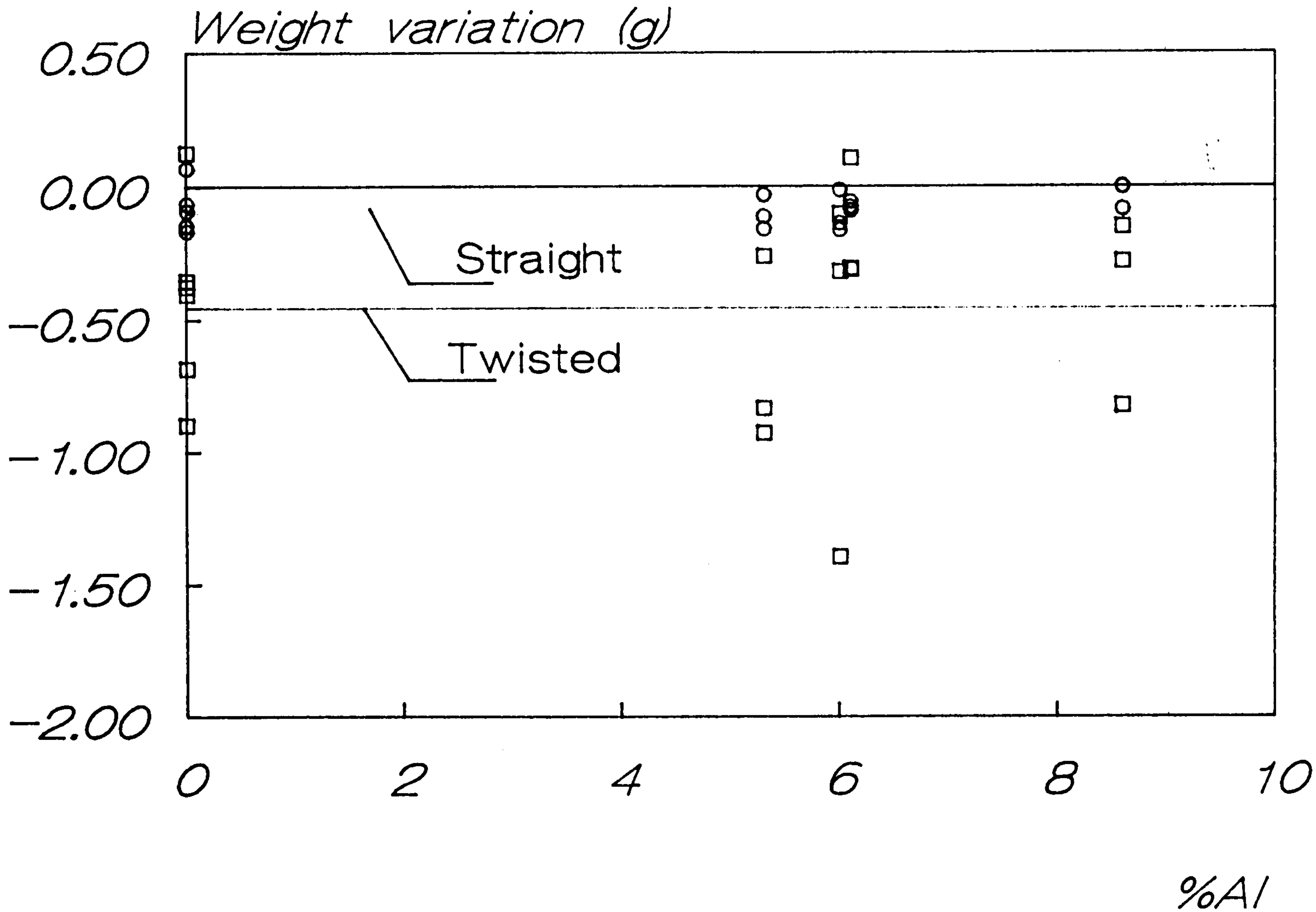
Products: Industrial galvanised and Galfan wires from BEKAERT
FICAL

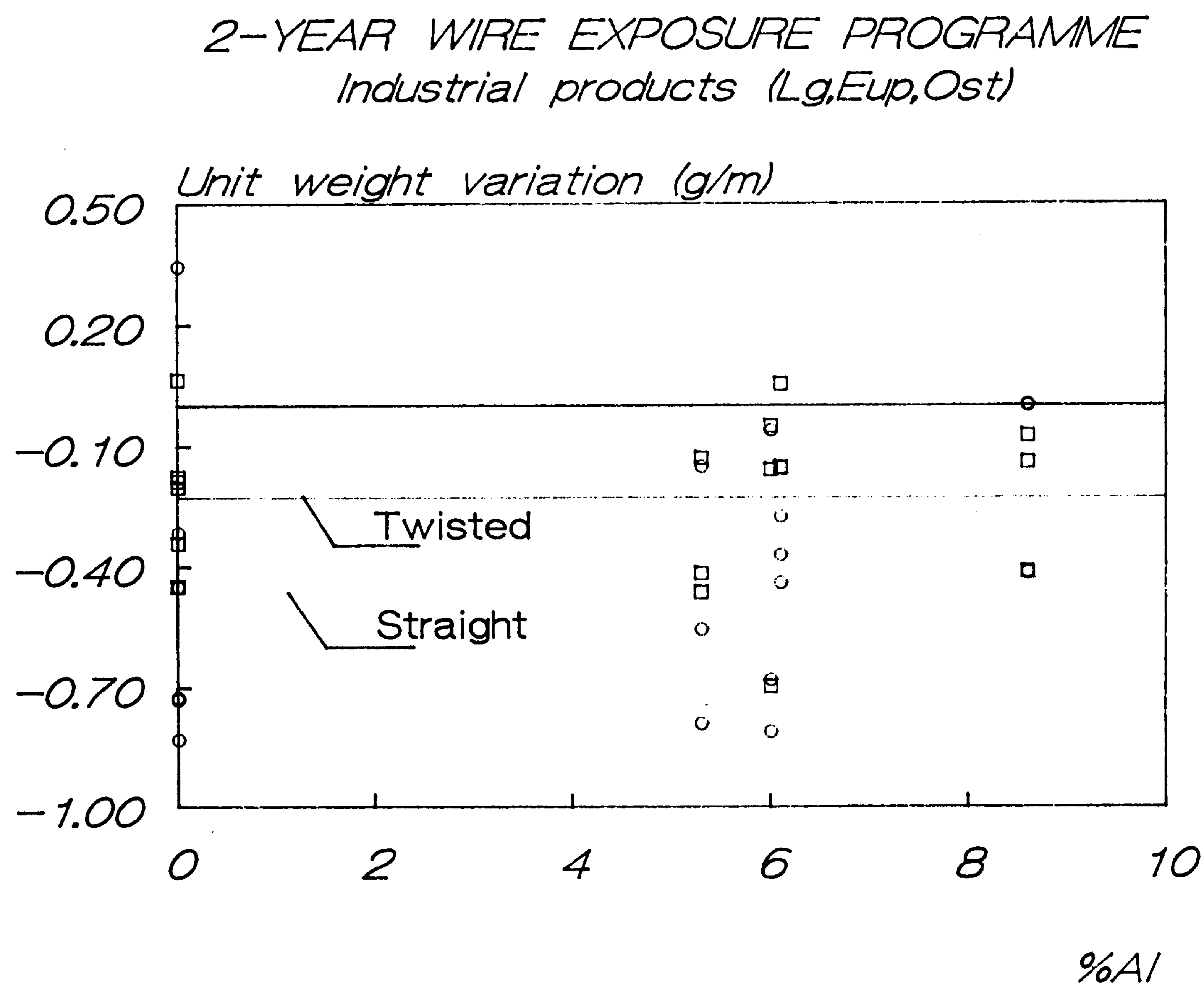
Diameter: 1.76, 1.78, 2.05, 2.08, 20.9 and 2.13 mm
Twisted (2m long) & straight (0.2m long) wires

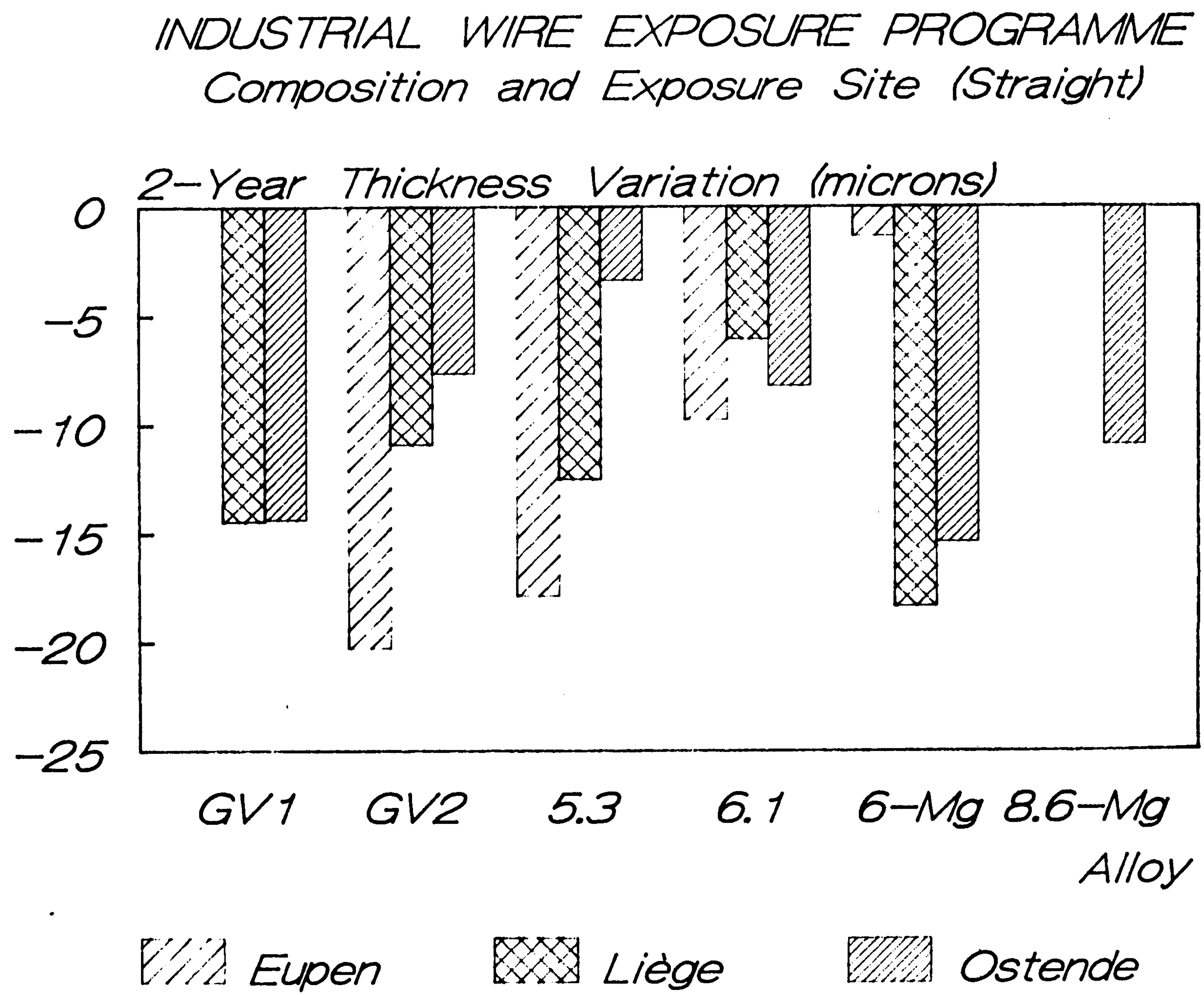
| %Al | %Mg | %Fe | ppmPb | Wire diam. | Number of dips |
|---|---|---|---|---|---|
| 5.3 | | 0.26 | 20 | 2.084 mm | 1 |
| 6 | 0.0036 | 0.89 | 20 | 2.05 mm | 2 |
| 6.1 | | 1.12 | 120 | 2.086 mm | 2 |
| 0.001 | | 1.13 | 50 | 2.134 mm | 1 |
| 0.004 | | 2.17 | 600 | 1.762 mm | 1 |
| 8.6 | 0.0714 | 1.9 | 340 | 1.782 mm | 2 |

Exposure sites: Eupen (Rural)
Liège (Industrial)
Ostende (Marine)

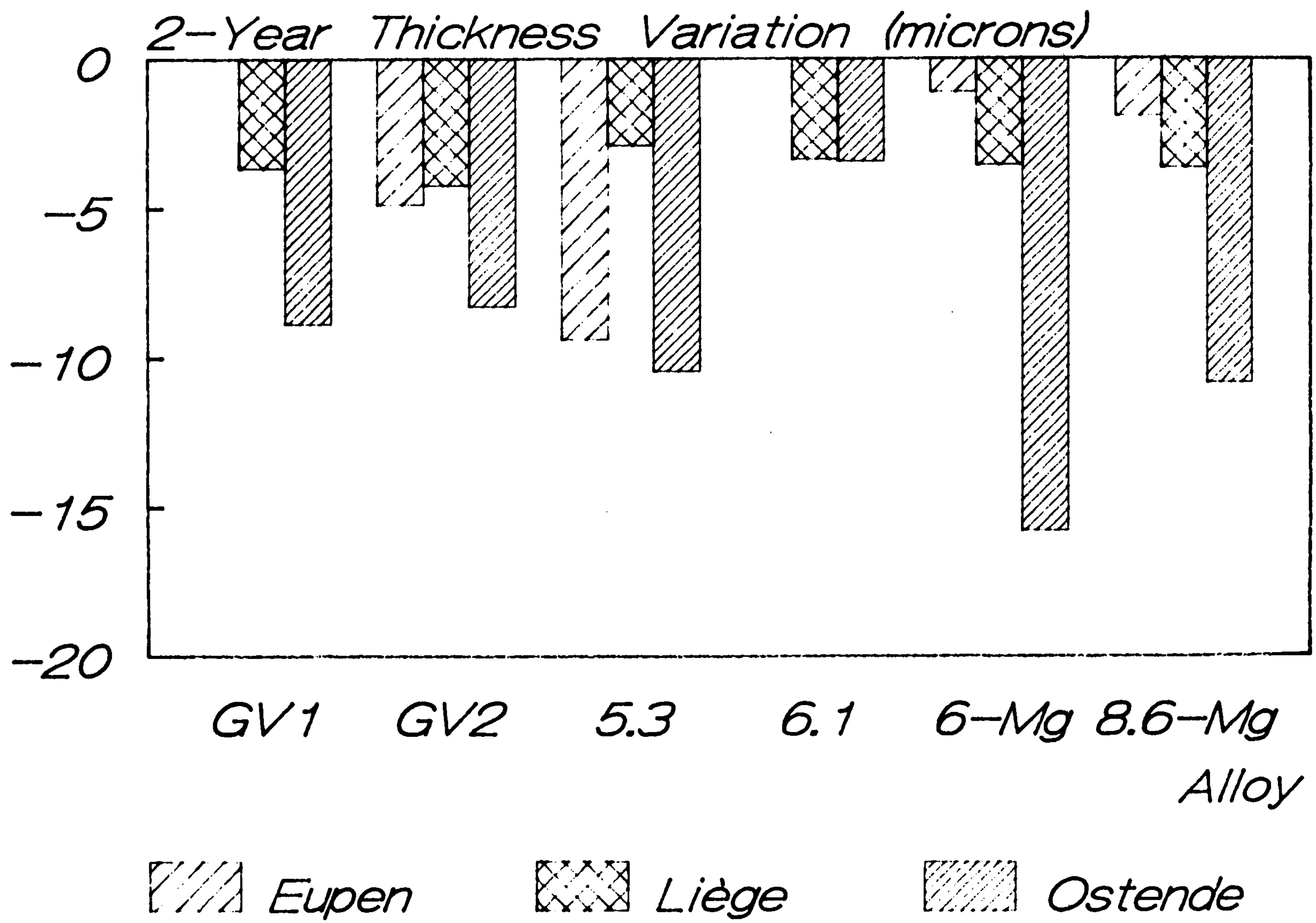
## 2-YEAR WIRE EXPOSURE PROGRAMME
### Industrial products (Lg,Eup,Ost)



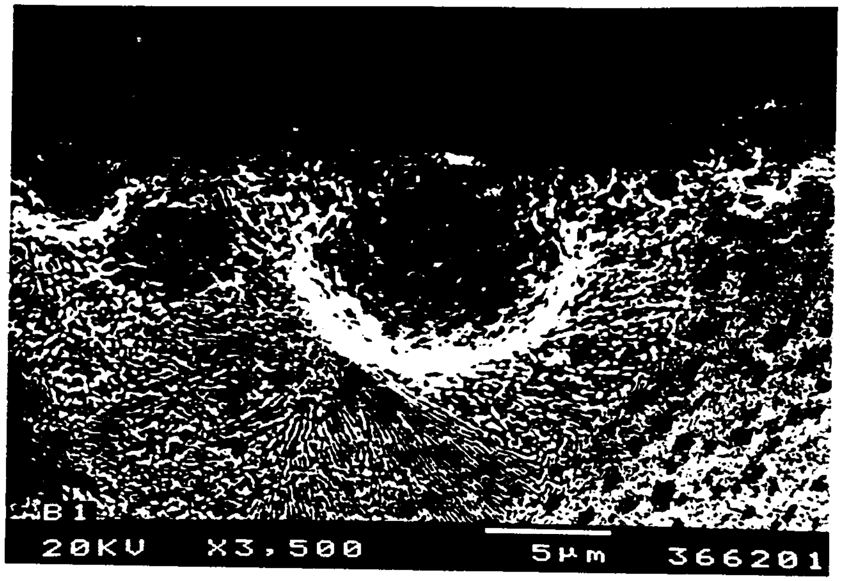

2–YEAR WIRE EXPOSURE PROGRAMME
Industrial products (Lg,Eup,Ost)
Unit weight variation (g/m)
0.50
0.20
–0.10
–0.40
–0.70
–1.00
0
2
4
6
8
10
%Al
Twisted
Straight

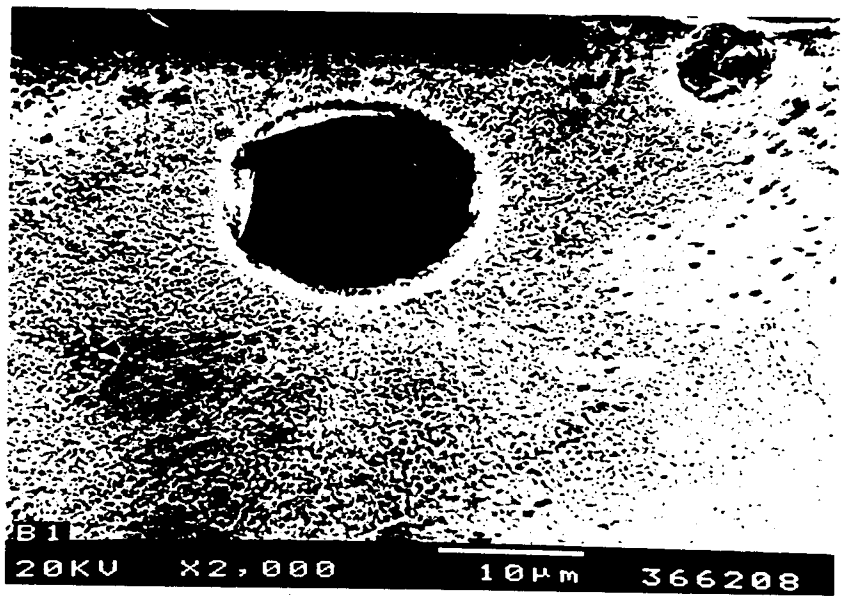

INDUSTRIAL WIRE EXPOSURE PROGRAMME
Composition and Exposure Site (Straight)
2-Year Thickness Variation (microns)
0
-5
-10
-15
-20
-25
GV1
GV2
5.3
6.1
6-Mg
8.6-Mg
Alloy
Eupen
Liège
Ostende

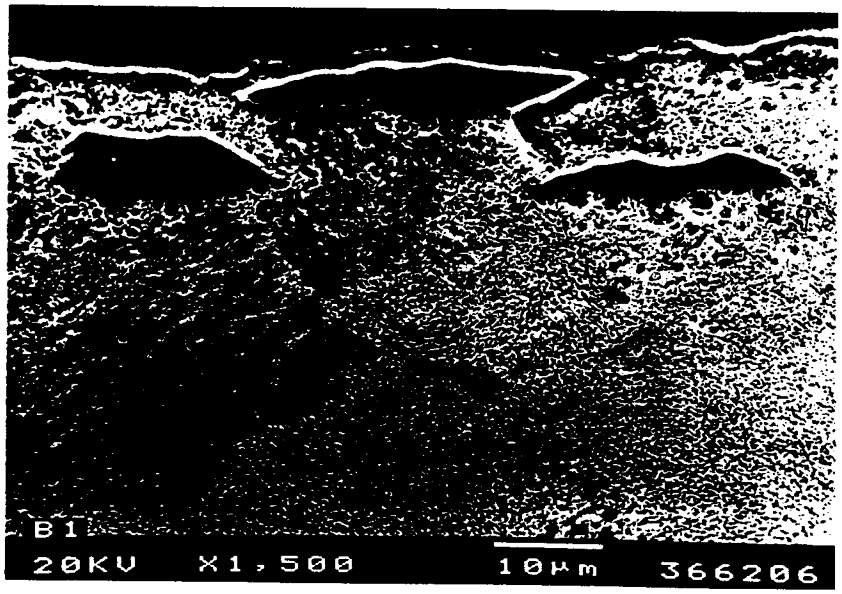
INDUSTRIAL WIRE EXPOSURE PROGRAMME
Composition and Exposure Site (Twisted)



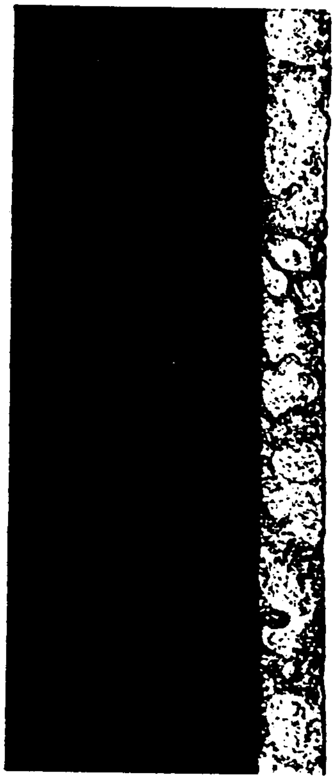
5.3 % Al - 0.26 % Fe - 20 ppm Pb



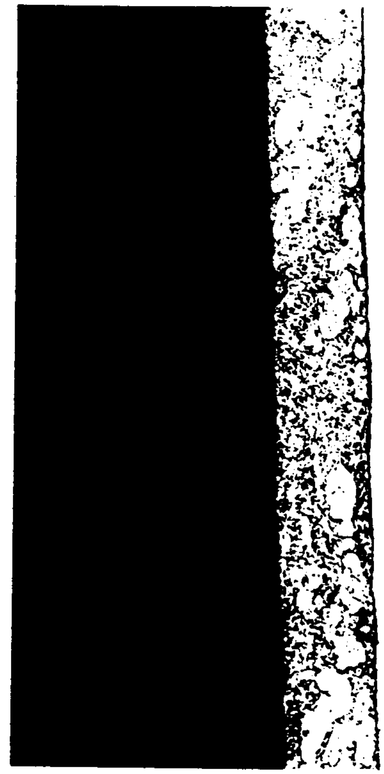



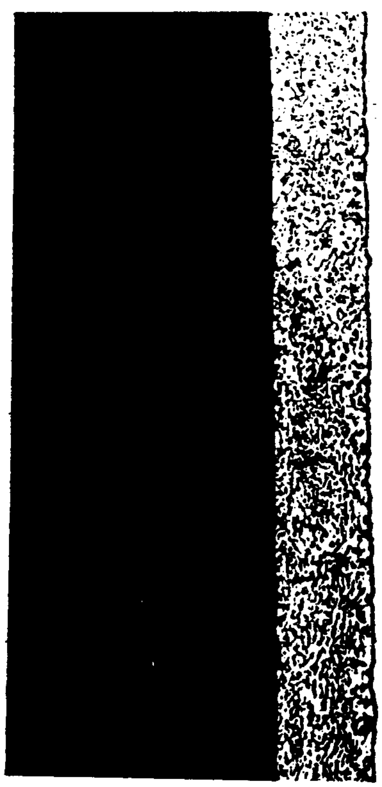
Galfan + Mg : Initial coating structure
Accelerated cooling



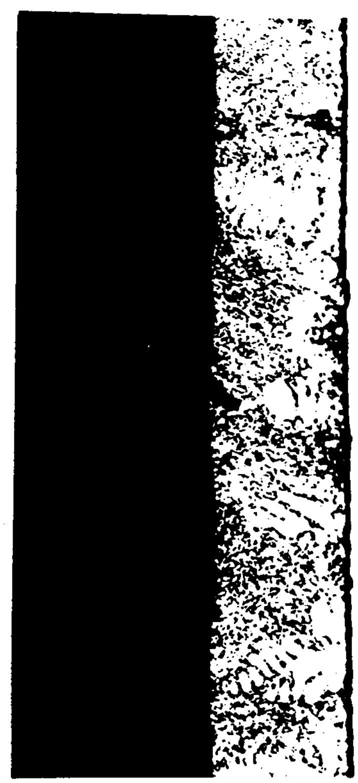
88 / 233 / 4 4.0 % Al - 0.03 % Mg



88 / 233 / 7 4.6 % Al - 0.048 % Mg

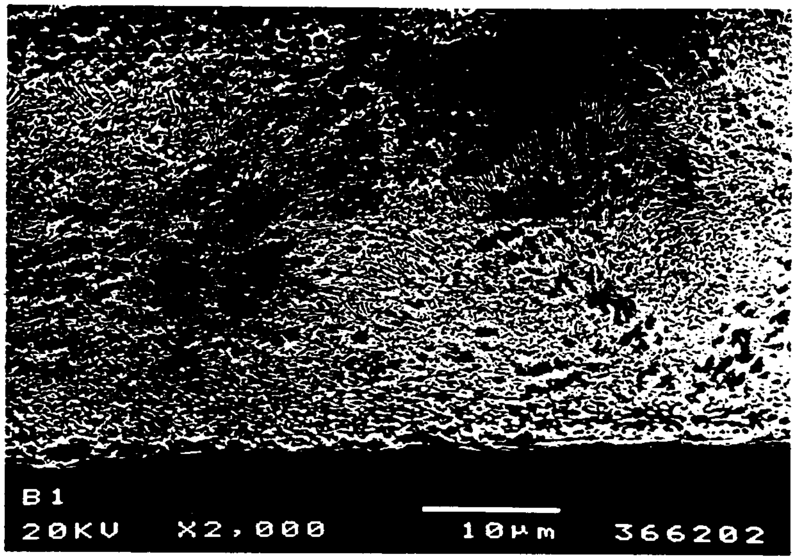


88 / 233 / 12 5.2 % Al - 0.054 % Mg

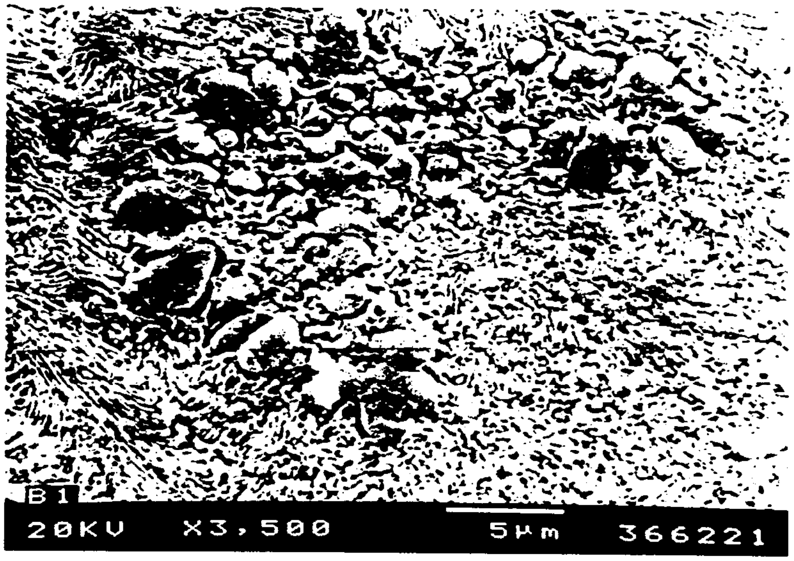


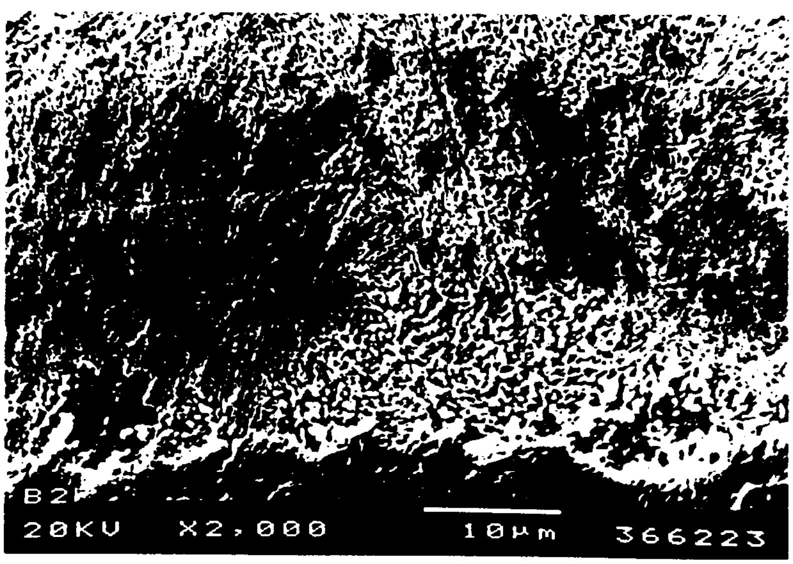
88 / 233 / 15 5.2 % Al - 0.08 % Mg

Industrial wire exposure programme (2)    Structure comparison




5.3 % Al - 0.26 % Fe - 20 ppm Pb




6.0 % Al - 0.0036 % Mg - 0.89 % Fe - 20 ppm Pb

# INDUSTRIAL GALFAN WIRE EVALUATION

Origin: Three wire specimens, 2.6, 3 and 3.6 mm in diameter
Transmitted to CRM on 27-Feb-89 by Mr Marshall ROMAN

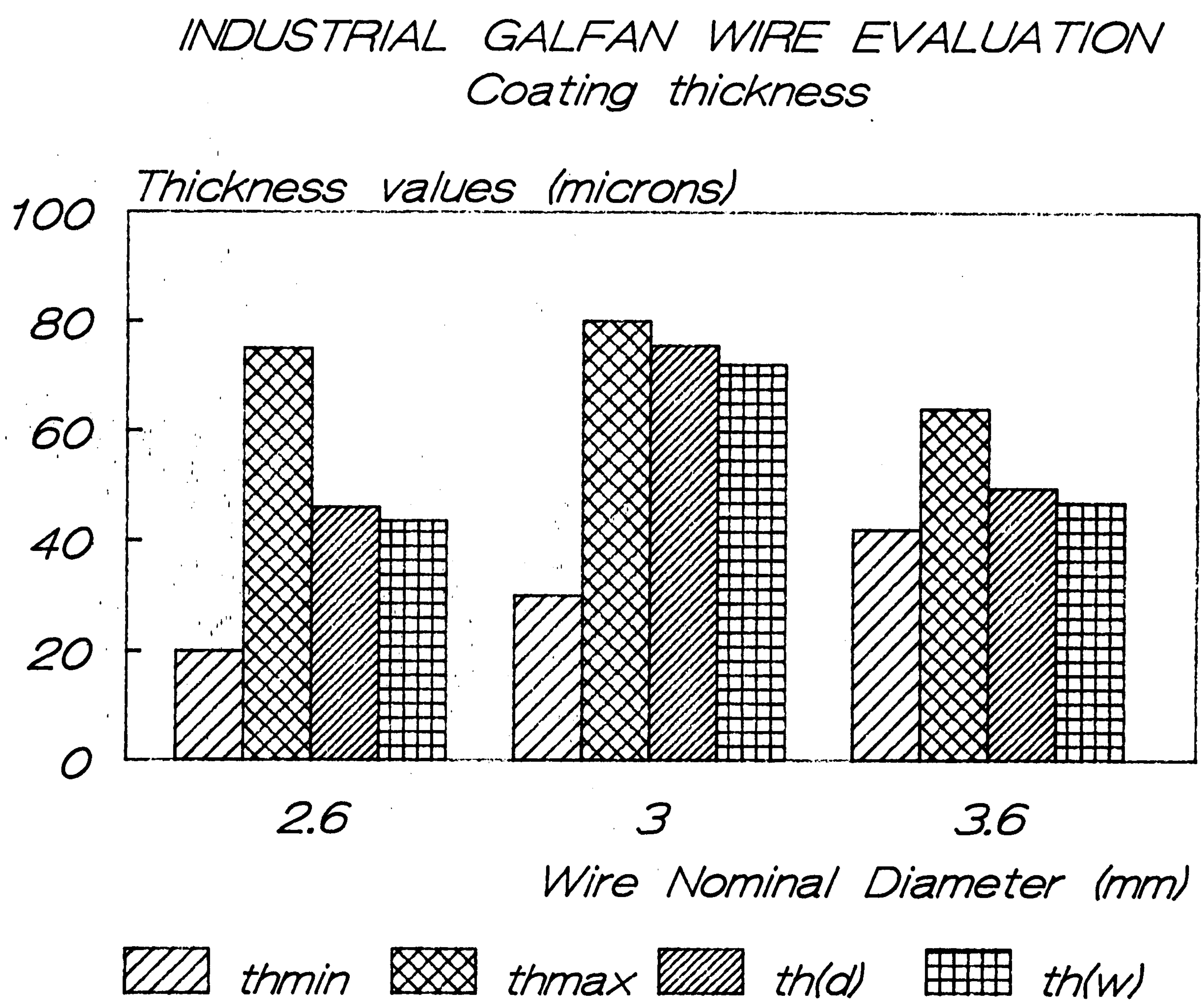
Purpose: Chemistry of the Galfan coating
Coating thickness
Coating homogeneity (Concentricity)
Microstructure
Adherence and ductility
Corrosion resistance

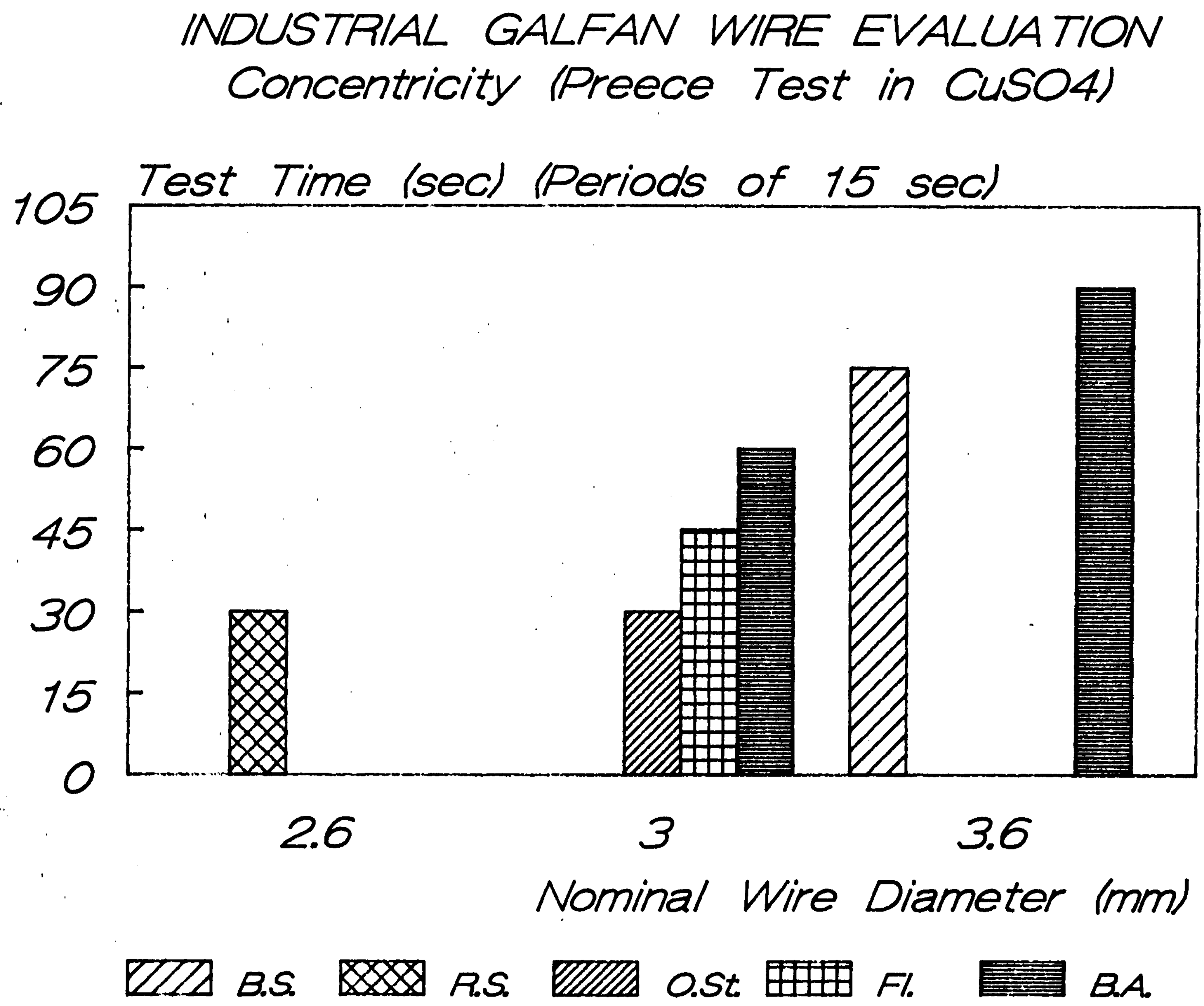
Experimental procedures: Chemical analysis
Dimensional measurements
Acid coating dissolution
Weight loss determination
Preece tests
Optical metallography
Bend tests (2T)

# INDUSTRIAL GALFAN WIRE EVALUATION

## COATING CHEMISTRY

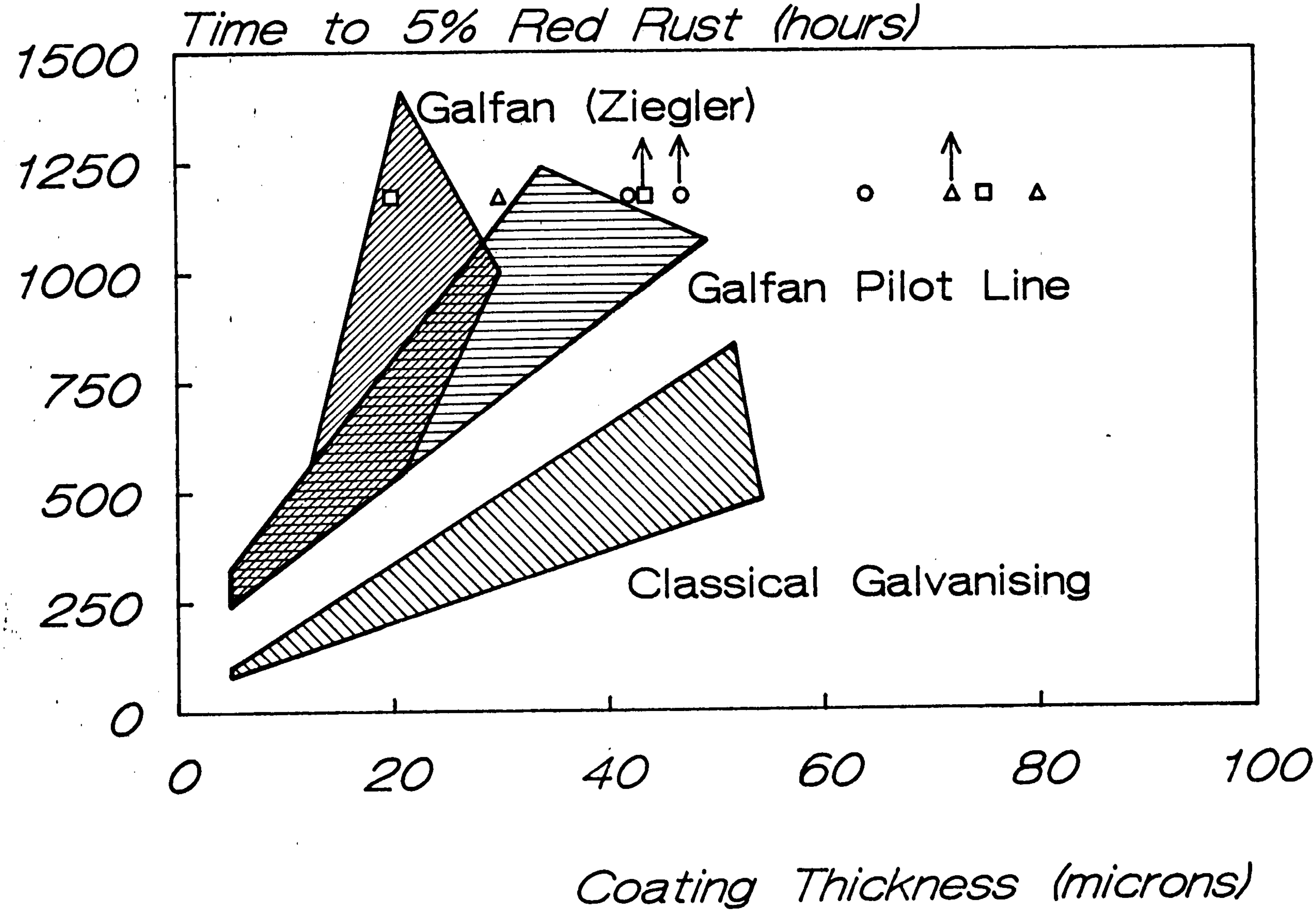
| Diameter (mm) | %Fe | %Al | %Mg | %Pb |
|---|---|---|---|---|
| 2.6 | 0.21 | 4.96 | <0.001 | 0.008 |
| 3.0 | 0.20 | 5.18 | <0.001 | 0.006 |
| 3.6 | 0.23 | 5.23 | <0.001 | 0.009 |


INDUSTRIAL GALFAN WIRE EVALUATION
Coating thickness
Thickness values (microns)
100
80
60
40
20
0
2.6
3
3.6
Wire Nominal Diameter (mm)
thmin
thmax
th(d)
th(w)


INDUSTRIAL GALFAN WIRE EVALUATION
Concentricity (Preece Test in CuSO4)
Test Time (sec) (Periods of 15 sec)
105
90
75
60
45
30
15
0
2.6
3
3.6
Nominal Wire Diameter (mm)
B.S.
R.S.
O.St.
Fl.
B.A.

# INDUSTRIAL GALFAN WIRE EVALUATION

## Salt Spray Test (Goodwin, 1983)



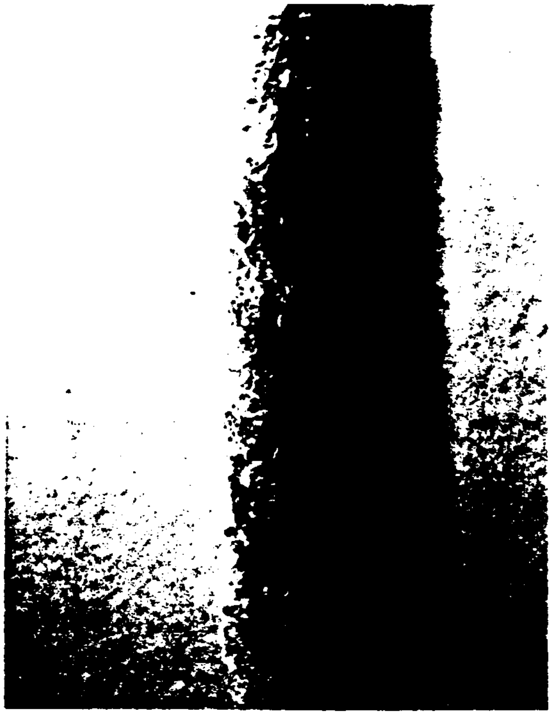
Industrial Galfan wire evaluation : Salt spray test - As tested condition

ø 2.6 mm X 5

ø 3.0 mm X 5

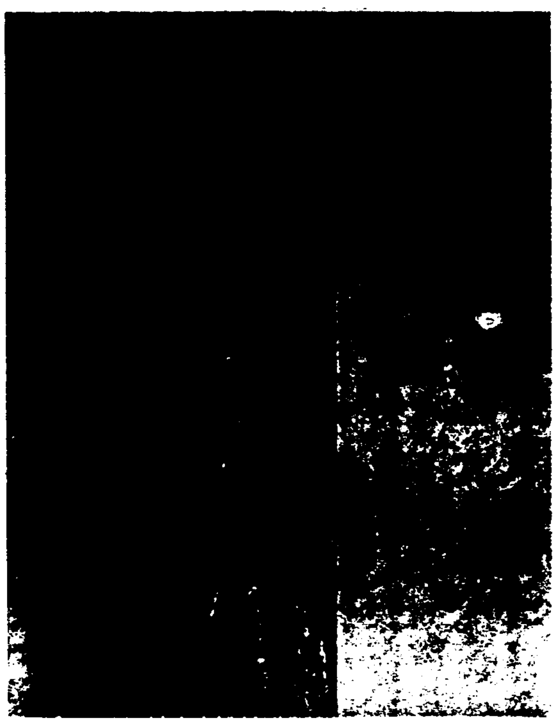
Φ3.6 mm X5

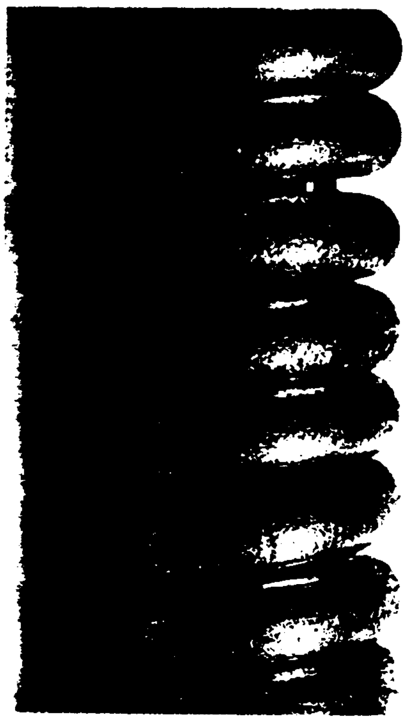
*Industrial Galfan wire evaluation : Salt spray test - As cleaned condition*



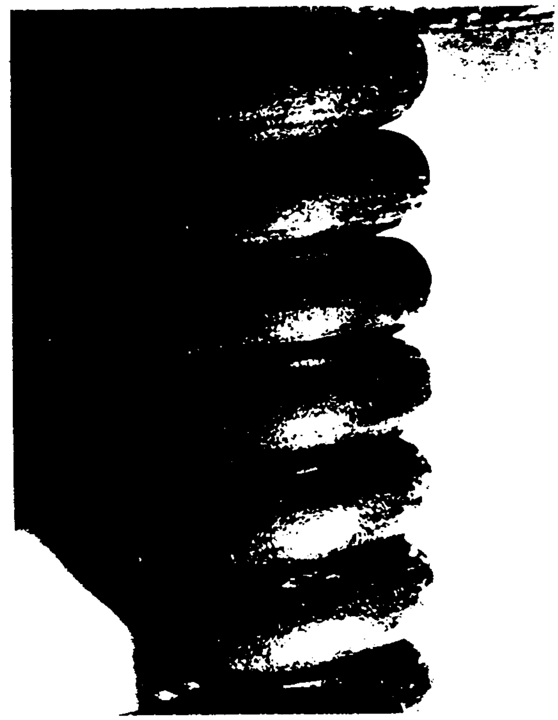
ø 2.6 mm X 5

ø 3.0 mm X 5

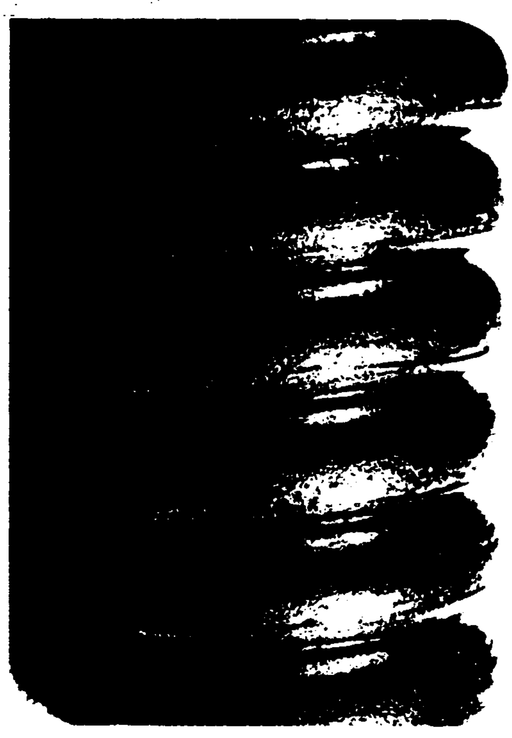




ø 2.6 mm X 5



ø 3.0 mm X 5



ø 3.5 mm X 5

Forth GALFAN Wire Licensee Meeting

OPERATIONS SESSION

Hotel Hesperia

Mannerheiminte 50

00260 Helsinki , Finland

# KAWATETSU WIRE CO. , LTD.

# GALFAN WIRE OPERATION

July 7 , 1989

KAWATETSU WIRE PRODUCTS CO. , LTD.

1. Introduction

We , Kawatetsu Wire Products Co., LTD., introduced the GALFAN technology of Zinc-Aluminum alloy coating for steel wire products , May 1989 . We have been operating and producing trial products and mainly investigating GALFAN coating weight control , surface condition control and fatigue property improvement .

The outline of facility , trial operating and trial product's properties of our new GALFAN line are described .

2. Outline of our new GALFAN line

The outline of our new GALFAN wire facility is shown in Tabel 1 . The furnace is pot type and its matelial is casting alloy iron . The size is as follws ; lenght : 5.5 m ., width : 0.5 m and depth : 1.4 m . Wire speed is valiable from 6.3 to 63 m/min .

Trial operating conditions are shown in Table 2 . GALFAN bath temperature is 430 to 445 ℃ , immersion length is 3.5 to 5.2 m , and so on .

The coating weight could be controlled by controlling the wire speed and bath temperature . Wiping technics have been experimented to improve the surface condition .

3. Expected use of GALFAN wire

GALFAN wire products are expected to be adopted by NTT for use in overhead and communications cables where high corrosion resistance , " the red rust should not appeare to 1,500 hrs in SST ," is required . Other likely applications include products for use in the electric power industry and fishers , and guard cables and other items for civil engineering .

Coating weight is varied with wire speed and bath temperature , and its variation in longitudinal direction is small range , as shown in Fig.1 and Fig.2 .

The structure of water-cooled GALFAN coated layer changes remarkably at each position of wire , as shown in Photo.1 . The colour vary from white to black .

Some surface defects is shown in Photo. 2 .

We will investigate the reason of structure change and these defects .

[illegible]

| Items | | Specification | | |
|---|---|---|---|---|
| Furnace | Type | Pot | | |
| | Material | Casting iron | | |
| | Size ( m ) | Length | Width | Depth |
| | | 5.5 | 0.5 | 1.4 |
| Sinker roller | Diameter ( m ) | 0.6 | | |
| | Material | Stainless steel | | |
| Number of strand | | Max. 5 | | |
| Coating speed ( m/min ) | | 6.3 ~ 63 | | |
| Diameter of wire ( mm ) | | 2.0 ~ 6.0 | | |
| Trial method of wiping | | Be developing in present<br>・ $N_2$ wiping<br>・ Active carbon<br>・ so-called " gravel "<br>・ LPG | | |
| Cooling | | Air cooling and water cooling | | |

| Market field | Expected use |
|---|---|
| Telephone and telegrah | Overhead and communication cable , etc |
| Electric power industry | Likely above use |
| Fisheres | Ropes and wires |
| Civil engineering | Guard cables , net and others |

| Items | Range of trial condition |
|---|---|
| Temperature of GALFAN bath (℃) | 430 ~ 445 |
| Immersion length ( m ) | about 3.5 ~ 5.2 variable |
| Wire speed ( m/min ) | 30 ~ 40<br>( Experimental max. 70 ) |
| Wiping condision | Active carbon with special oil and $N_2$ gas |
| Coated weight ( $g/m^2$ ) | 300 ~ 430<br>( Experimental max. 650 ) |
| Chemical composition ( wt. % ) | Al / M.M. / Fe<br>Alloy: 5.2 / 0.10 / 0.01<br>Bath: 5.20 / <0.004 / 0.001<br>Coated layer: 6.68 / —— / 3.79<br>( include intermetallic layer ) |

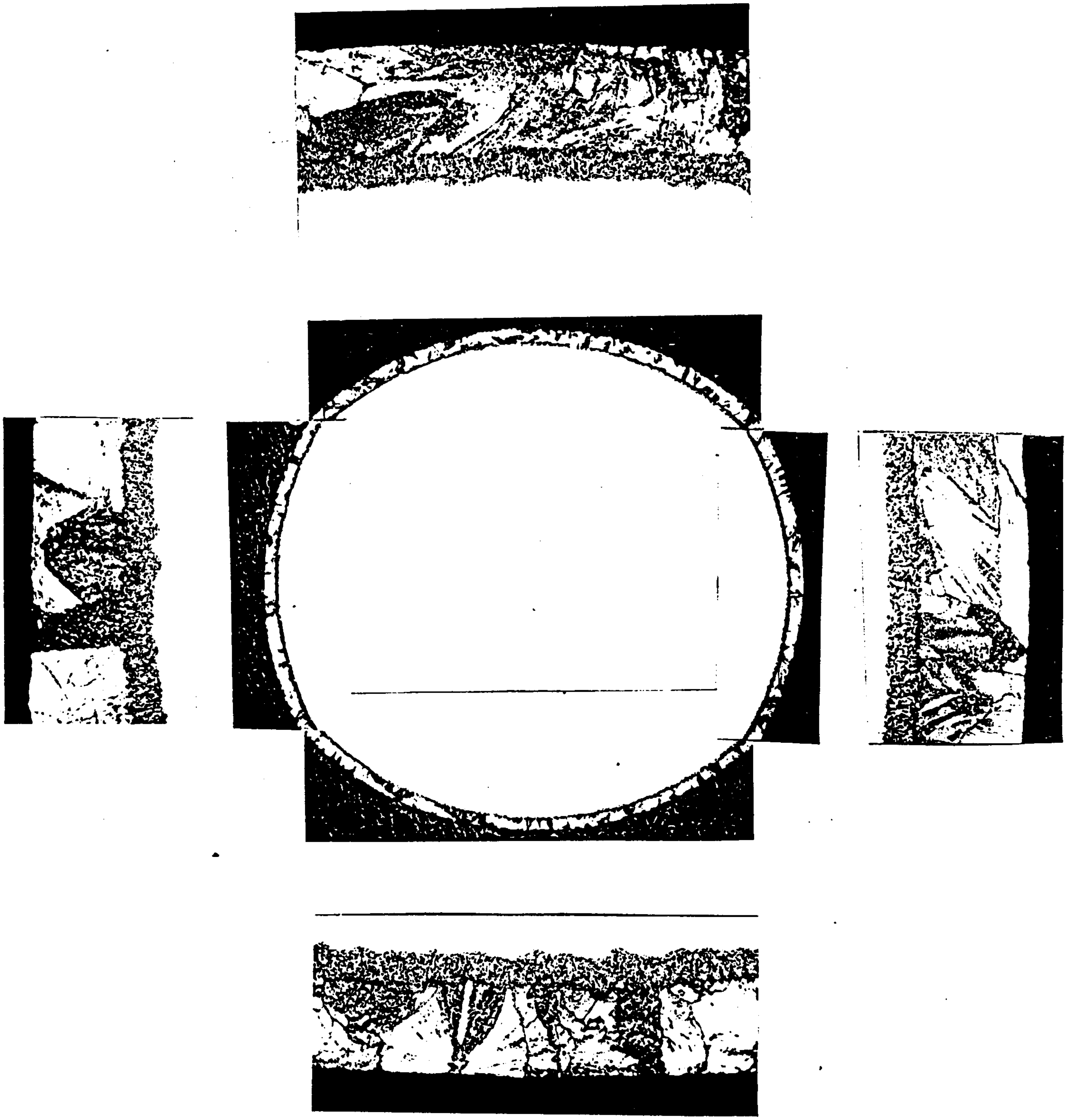
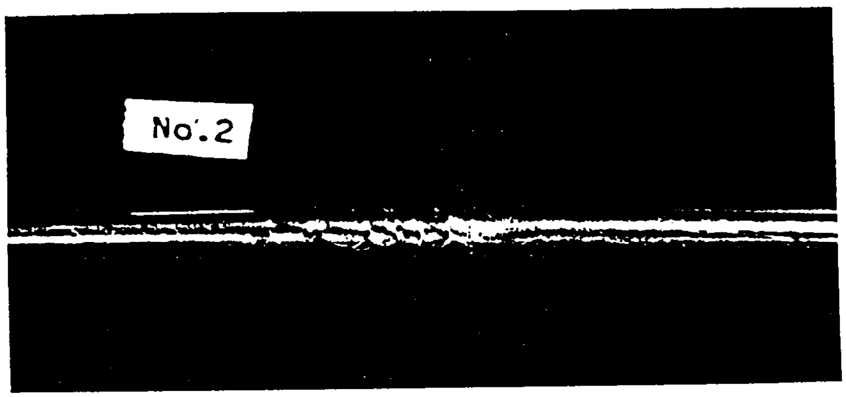
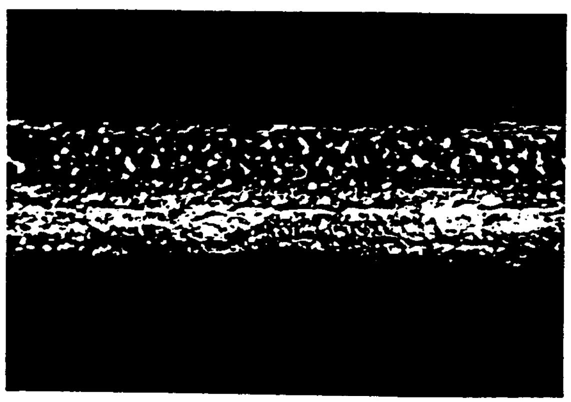


Photo. 1 Optical structure of trial GALFAN coated wire.

cross section




a) Spiral grooving ×2



b) Small crack crowd ×5

Photo. 2 Aspet of some surface defects.

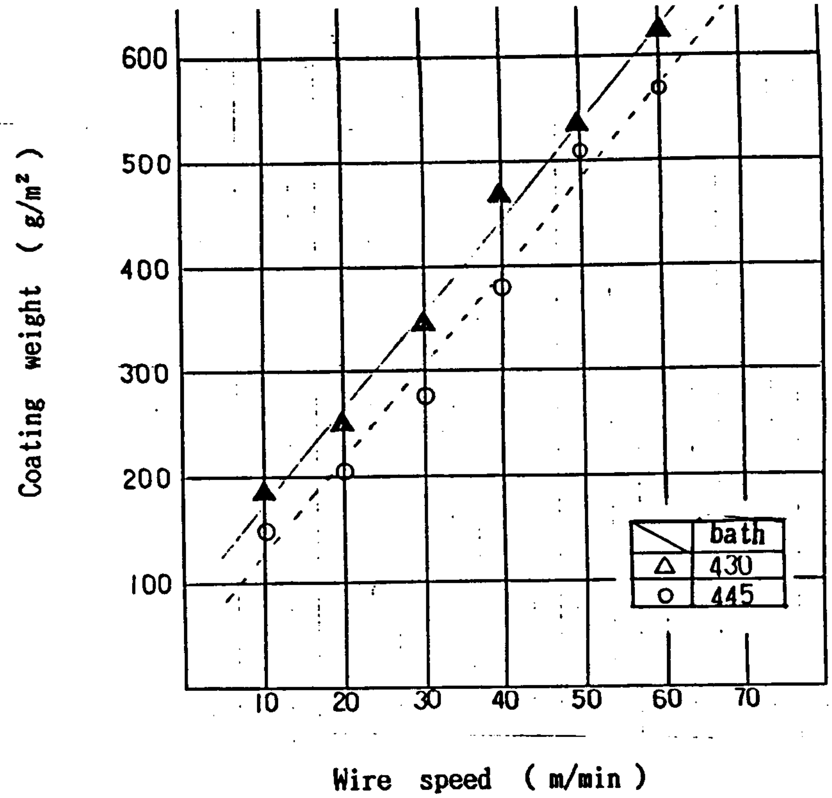



Fig. 1 Effet of wire speed on the coating weight .

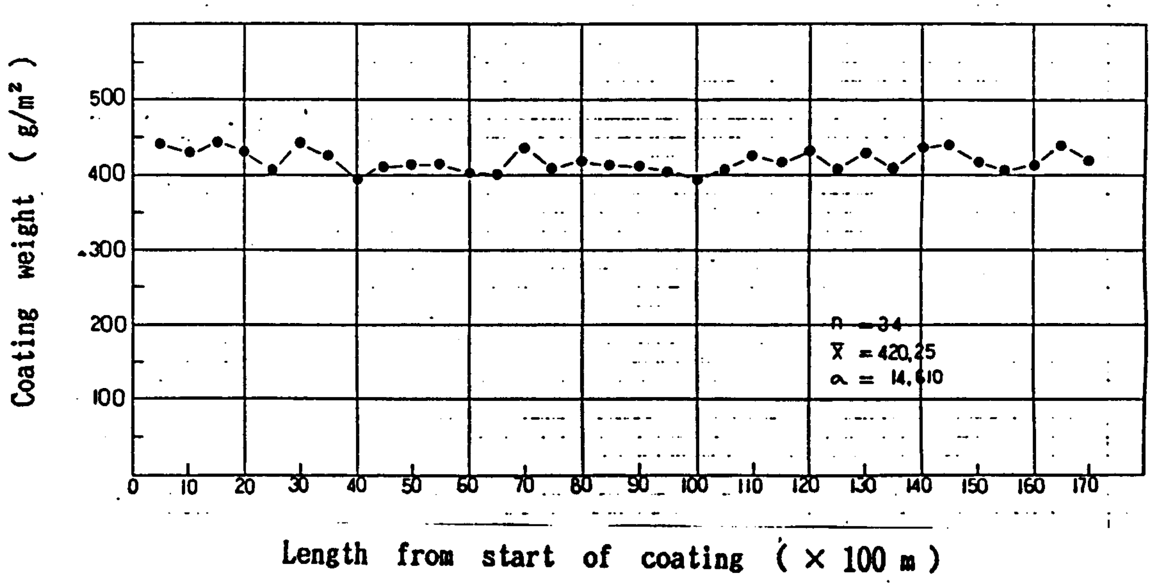



Fig. 2 Variation of coating weight .

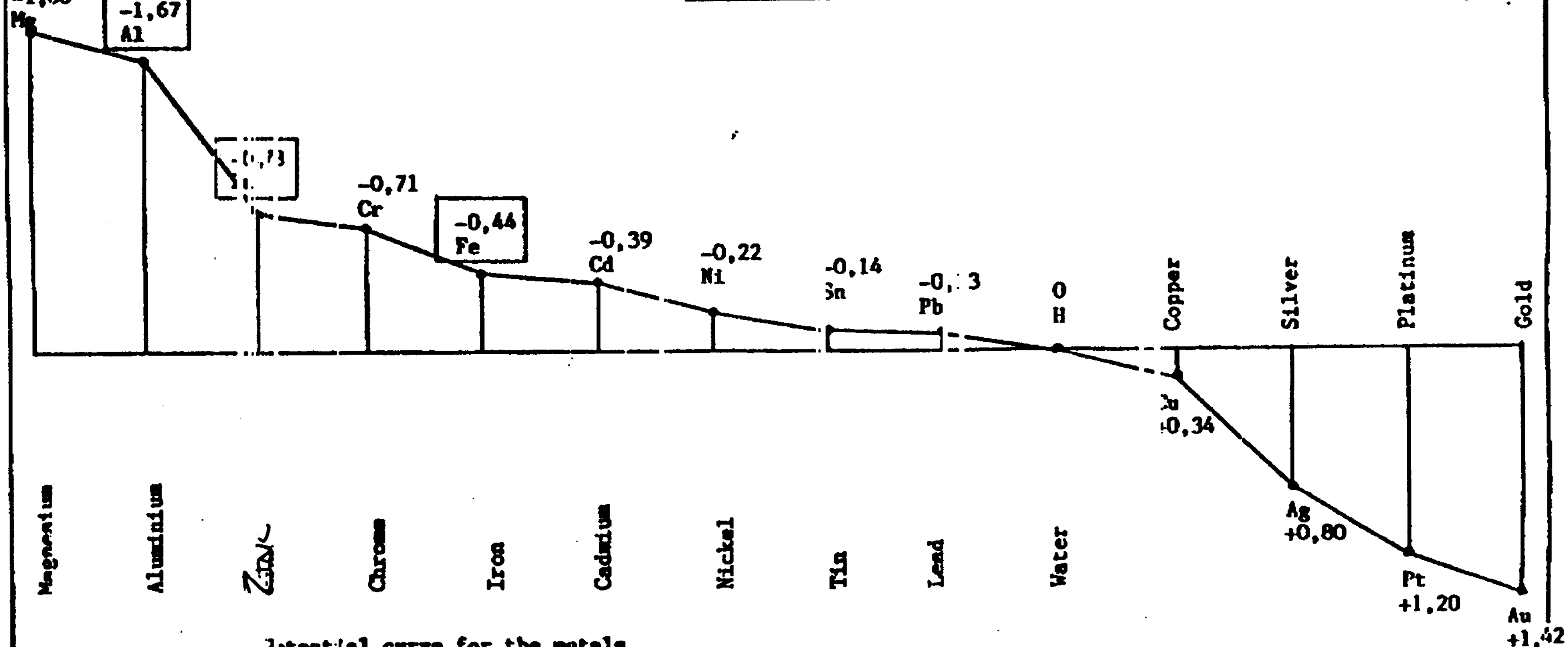
# B E Z I N A L

( GALFAN )

A NEW GENERATION IN

METALLIC COATING

## WHY GALFAN




Potential curve for the metals

In the corrosion resistance Aluminium and Zinc
in their alloy layer formation are

"the best of two worlds"

When the coating reacts homogeneously in the
cathodic protection which is (on wire)
only a fact at the eutectic composition of Galfan

## PRODUCT CHARACTERISTICS

. COMPARABLE MECHANICAL PROPERTIES OF GALVANIZED AND GALFANISED STEEL WIRES.

. BETTER CORROSION RESISTANCE IN ACCELERATED CORROSION TESTS AND IN OUTDOOR EXPOSURE COMPARISONS.

. CATHODIC PROTECTION IS EQUIVALENT TO ZINC.

. EXCELLENT ADHESION BY LIMITED ALLOY LAYER THICKNESS.

DUE TO THE SPECIFIC OXIDATION OF ALUMINIUM AT THE SURFACE OF GALFAN COATINGS, A <u>DARKER</u> BUT <u>SMOOTHER</u> SURFACE OF THE EXPOSED GALFAN COATING CAN AND WILL BE OBSERVED.

THIS SMOOTHNESS OF THE GALFAN COATING OVER THE YEARS OF EXPOSURE WILL BE APPRECIATED IN THE VINEYARD INDUSTRY.

"KEIN VERGLEICHBARER WEINBERGDRAHT BLEIBT LÄNGER GLATT !".

## Advantages versus Galvanised wire

1. Corrosion rate
2. Smoothness
3. Adhesion to steel
4. Process control
   quality assurance
5. No zinc dust formation during drawing

SALTSPRAY-TEST
(ASTM B 117)

HIGH CARBON STEELWIRE

| | GALFAN | ZINC |
|---|---|---|
| COATING IN $G/M^2$ | | |
| H.P. | 331 | 399 |
| E.P. | 112 | 163 |
| TIME TILL REDRUST IN HRS. | | |
| H.P. | 1169 | 558 |
| E.P. | 277 | 163 |
| RESIDUAL COATING IN $G/M^2$ | | |
| H.P. | 64 | 148 |
| E.P. | 6 | 16 |
| COATING LOSS PER 100 ST. | | |
| H.P. | 23 | 46 |
| E.P. | 38 | 109 |

SEMI PRODUCT DIA. 3.5 - 4.20 mm
END PRODUCT DIA. 1.39 mm

# LOW CARBON APPLICATIONS

- VINEYARD WIRE

- FENCING

- WELDED MESH

# High carbon applications

- rope wire
- spring wire
- fishing / off–shore
- automobile
  - motor
  - windshield wiper wire
- TV – transmission towers

Galfan as coating on wire and wire products will be for some applications a substitute for :

- galvanised class B HiCa
- stainless steel Low Ca
  Medium

Cross section outer strands (...

## DWARSDOORSNEDE MANTELSTRENGEN

after 1 year exposure in sea water

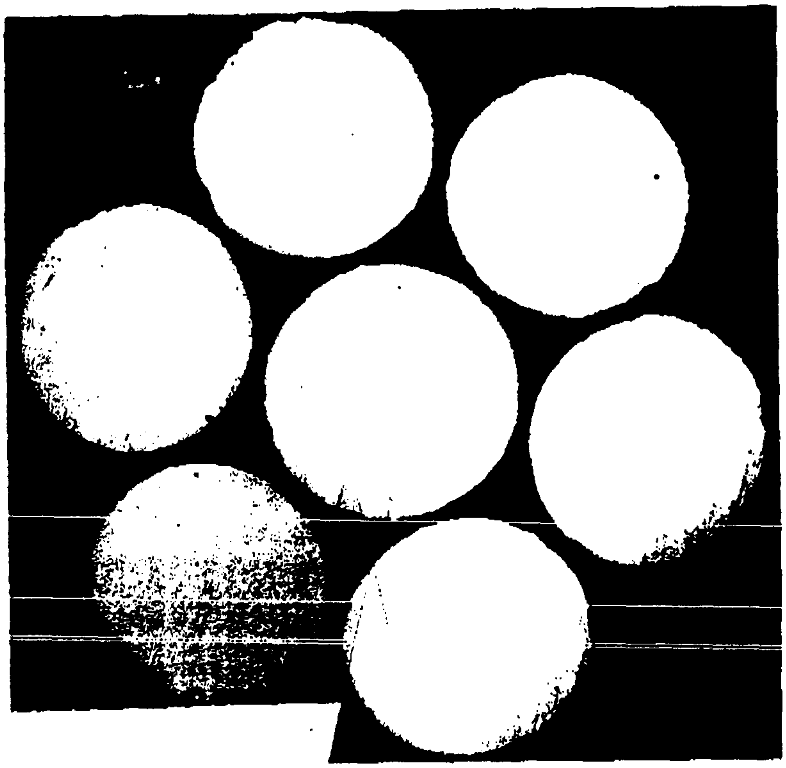
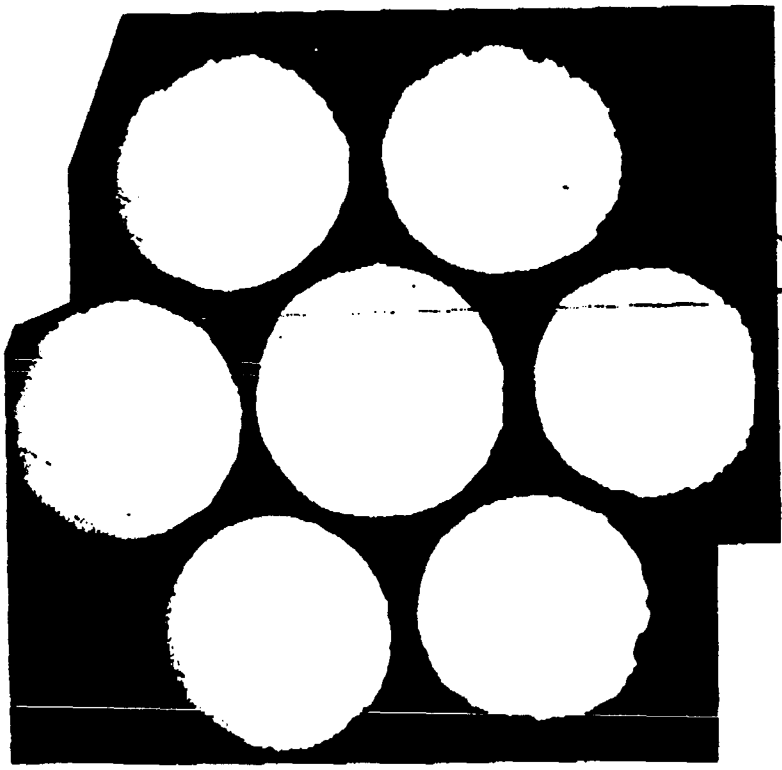


FOTO 3 : Galfan V : 20 x



Corrosion

FOTO 4 : Verzinkt V : 20 x