Program Preview

9th Continuous Steel Strip Plating Symposium

May 10–14, 1999 • Hyatt Regency, Chicago, IL

Sponsored by the Continuous Steel Strip Plating Committee of the American Electroplaters and Surface Finishers Society

Session Organizers

Dr. Henry Hahn
General Chairman
Bethlehem Steel Corp.
Dr. Chyang Jer Wu
Program Chairman
U.S. Steel of USX Corp.
John Bodnar
Hospitality Chairman
Double Eagle Steel Coating Co.

Monday Afternoon, May 10
Plant Tours
Metro Metals, East Chicago, IN
LTV Tin Mill, Indiana Harbor, IN
Noon—Buses depart from hotel
5:30 p.m.—Buses return to hotel

Monday Evening, May 10
Reception Sponsored by Suppliers

Tuesday Morning, May 11
Session I—Electrogalvanizing Line & Other Equipment

Session Chairmen: Dr. Mark Blaser, I/N Kote, New Carlisle, IN & Dr. Joseph Frimpong, Daniel Wean, Inc., Youngstown, OH

8 a.m.—Welcome & Opening Remarks

8:15 a.m.—Metro Metals' New Electrogalvanizing & Chemical Treatment Line
Tom Rondinelli, Metro Metals & William Carter, Ispat Inland, East Chicago, IN
Metro Metals recently started up a new electrogalvanizing line at its plant in East Chicago, IN. Many of the line's components were purchased from AK Steel after AK decommissioned the Armco No. 1 EGL. The equipment was moved to a brownfield site and erected in an existing building. The 72-in. wide line has five newly designed, horizontal plating cells and 230,000 A of capacity. The cells use adjustable, insoluble lead anodes and zinc sulfate electrolyte. The line is designed to make a wide range of toll-coated products, especially for light-gage and light coating weight applications. It has in-line phosphating and chromating chemical treatment systems.

8:45 a.m.—Improved Properties of IrO_2-based Anodes for HCD Electroplating
Ryuichi Otogawa, Koichi Soda & Shinji Yamauchi, Fine Chemical Department, Daiso Co., Ltd., Japan; & Masatsugu Morimitsu & Morio Matsunaga, Department of Applied Chemistry, Kyushu Institute of Technology, Japan
Electroplating techniques at high current densities (HCD), such as several hundred Adm^2, are a matter of worldwide concern for commercial electrogalvanizing and electrotinning of steel to develop a high productivity. HCD electroplating processes require an advanced oxygen evolution anode having high performance and durability. This paper will report on the developments of IrO_2-based anodes consisting of an IrO_2-Ta_2O_5 coating layer on a titanium substrate for HCD electroplating. The effects of several important factors, such as the composition and structure of the coating layer and the material of the constituents on the performances of the anode, have been examined. The proper composition and structure of the coating layer presented a high catalytic coating layer, which gave a low oxygen overpotential at the high current density. The interlayer between the catalytic layer and the substrate prolonged the lifetime, resulting that the cell voltage varied little during 4000 hr of continuous electrolysis. In this paper, we will also discuss the relationship between the catalytic activity and the microstructure of the improved anode.

9:15 a.m.—Permanent Media Filter Proves Itself in Continuous Steel Strip Plant
Ted Halahel, SERFILCO, Ltd., Northbrook, IL
Conventional filtration is labor-intensive and requires disposable media. This conventional technology can be replaced by automatic backwash filtration systems that utilize permanent media with low labor cost and no disposal of media. This was demonstrated at Weirton Steel on its continuous steel strip operation, which benefited from this new technology by reducing its labor and media costs. Equipment utilizing this tech-

nology provided a greater number of bath turnovers. This increase resulted in higher filtration rates for the solution and improved quality of the coating applied to the steel strip.

9:45 a.m.—Break

10:15 a.m.—High-efficiency Production Technology at Mizushima Works No. 2 EGL
Makoto Imamura, Shuji Kiyama, Naoki Sakai, Yuji Ikenaga, Osamu Shin & Takashi Sekita, Kawasaki Steel Mizushima Works, Japan
Construction of a new electrogalvanizing line was completed in 1991. Production includes pure Zn and Zn-Ni. In order to achieve high efficiency productivity, many new technologies have been adopted into the process, such as a new horizontal plating cell, zinc-metal dissolving equipment and an automated control system. The following technology was developed to save production costs, especially the cost of the Zn-Ni electrolyte: First, the zinc oxide dissolving unit was adapted to supply Zn ion for the Zn-Ni electrolyte. It operates smoothly and is supplying cheap zinc oxide to almost all the Zn-Ni plating products. Next, the nickel-metal dissolving unit was adapted to supply Ni ion. Originally, the nickel carbonate had been used as the Ni ion source, but new technology was developed to dissolve Ni metal, so it was used as the Ni ion source. With these high-level process techniques, No. 2 EGL can produce high quality and low-cost galvanized steel sheets.

10:45 a.m.—The Performance of Titanium Anodes in Electrogalvanizing
Kenneth L. Hardee & Carl W. Brown, ELTECH Systems Corporation, Fairport Harbor, OH
Titanium anodes with iridium oxide coatings are in widespread usage in electrogalvanizing and other high-current-density, oxygen-evolving systems. Significant improvements in lifetime have been accomplished by providing a high surface roughness prior to coating and by inhibiting the passivation of the titanium substrate. The surface roughness provides enhanced coating adhesion and reduced effective current density. The passivation of the titanium substrate is the principal failure mode of titanium anodes and is inhibited by intermediate layers. The development of electrochemical impedance spectroscopy techniques enable the detection of the formation of this passive layer, even in the presence of surface deposits. With these tools, surfaces and coatings can be controlled to tailor the anodes to meet the requirements of a given system. With control of the anode properties, reproducible, standard lifetimes are achievable that allow anode replacement at intervals convenient with system maintenance schedules.

11:15 a.m.—A Case Study: Implementing EMS Recordkeeping
Andrew M. Yaksic, Double Eagle Steel Coating Company, Dearborn, MI & John S. Vargo, Hands & Associates, Inc., Detroit, MI
Successful implementation of environmental management system (EMS) recordkeeping can reap immediate and long-term benefits to a company that is proactive and wants to control its future. Additionally, implementing EMS recordkeeping will help make the company's environmental manager's job easier by allowing him to "get his arms around" key issues. EMS recordkeeping was installed according to a strategic plan developed using a partnership approach with Double Eagle Steel Coatings Company's (DESCO) management. As in QS-9000 and similar programs, the company's upper management's philosophy, vision, belief and support was crucial. The new system makes business sense rather than being considered: (1) A reactionary approach to environmental issues of the day; and/or (2) compliance- or regulator-driven. The system provides DESCO with progressive structural control of its environmental documentation and recordkeeping. This control promotes strategic thought and planning in lieu of daily reactionary response to problems that reoccur. Additionally, the system involves a continuous improvement approach, whereby the filing system evolves and improves with time. This presentation examines DESCO's previous system, and implementation and benefits of the new system.

11:45 a.m.—Maintenance & Recovery of Process Water & Chemicals in Continuous Steel Strip Plating Operations Using Innovative Technologies
Fred P. Reinhard, CH2M HILL, Eagan, MN
Pollution prevention (P2), wastewater treatment, chemicals and water recovery and purification are today integral processes in fabricating operations of the electroplating and surface finishing industries. Surface coating is one of the processes following steel forming operations. In electrolytic coating (electroplating), the steel strip is continuously passed through aqueous solutions of surface treatment baths for cleaning, pickling, metal coating and passivation. The use of rinse water and many of the surface treatment baths are comparable with electroplating operations. This paper will discuss and evaluate areas of continuous steel strip plating, where innovative technologies such as diffusion dialysis, membrane electrolysis, advanced reverse osmosis, micro/ultrafiltration, adsorption filtration and modular ion exchange can help to minimize the generation of hazardous waste and significantly reduce consumption of chemicals and process water. For most of these technologies, if appropriately applied, a return on investment can be anticipated.

12:15 p.m.—Lunch

Tuesday Afternoon, May 11
Session II—Tinplate

Session Chairmen: Richard Steinbicker, Bethlehem Steel Corp., Behlehem, PA & John Swanson, LeaRonal, Inc., Freeport, NY

1:30 p.m.—A Comparative Study of Halogen & Methane-Sulfonic-Acid Electrotinning Processes
Yung-Herng Yau, Bethlehem Steel Corporation, Bethlehem, PA
The characteristics of a typical halogen and a patented methane-sulfonic-acid-based (MSA) electrotinning process were studied using laboratory tests. The stability of the bath and its corrosivity toward the steel substrate were evaluated simultaneously by a "spinning disc" experimental technique. The results show that the MSA bath is very stable, with a low oxidation rate of stannous ions, but is much more corrosive to the steel substrate. The effects of operating conditions (such as line speed and current density) on the plating efficiency, coating morphology and preferred crystal orientation were investigated using a rotating cylinder cathode. Comparison of the plating efficiencies obtained from this cathode and production identified a window of test conditions that is representative to that of production. Within this window, the MSA process offers a higher plating efficiency at high current densities, but different microstructure and preferred crystal orientation as compared with those of the halogen process. The coating morphology in the MSA bath also exhibits a greater variation at low current densities, resulting in a narrower operating window. In both processes, the grain size increases in the directions parallel as well as normal to the steel substrate. This three-dimensional grain growth is accompanied by a continuing change in crystal orientation, suggesting that recrystallization takes place during these two electrotinning processes.

2 p.m.—The Effect of Organic Additives on Operating Window & Characteristics of Tin Deposits from MSA Electrolyte
M. Sun, K.C. Liao & F. Bottos, National Steel Corp., & J.L. Swanson & G. Federman, Lea Ronal Inc.
The effect of organic additives and operating conditions on characteristics of tin plate has been studied. Hydrodynamically controlled Hull Cell (HCHC), rotating disc electrode, and flow cell system were used to obtain tin deposits under different operating conditions. An MSA bath with proprietary HCD additives (primary plus secondary) has a wide range of operating window that includes: Higher operating temperature, faster line speed and wide current density range. It also yields tinplate of good appearance in both matte and melted finish. The change in the tin crystal orientation as a function of plating current density was also studied via X-ray diffraction. A Tin Gloss Index (TGI, defined as TGI = $T_{101}/(I_{200} + I_{220} + I_{211} + I_{112} + T_{321})$, has been used to correlate the surface appearance with tin crystal orientation. The crystal orientation results indicate that Tin Gloss Index can be used as an indicator to predict the surface appearance of tin plate.

2:30 p.m.—Longitudinal & Transverse Primary Current Distributions in Horizontal Tin Plating Cells
Conrad B. Diem, Bethlehem Steel Corporation, Homer Research Laboratories, Bethlehem, PA
Two-dimensional primary current distributions were calculated for horizontal tin plating cells in both the longitudinal and transverse directions, using geometric parameters typical of those found in Bethlehem Steel's Sparrows Point Halogen lines. The calculations were performed using a commercial finite-element code. The effects of the anode-strip gap, strip thickness, and the solution surface profile were investigated. The most significant findings from the calculations were that the current densities near the edges of the strip, even on the top side, are very high, and that almost all of the plating occurs

directly across from the anode beds. Coating weight distributions from samples of tinplate specially produced with plating on only one tier were compared with the calculated transverse distributions and confirmed the validity of the primary distributions except within about 2 mm from the edges, where the primary current density tends toward infinity. Both the longitudinal and transverse distributions provide insights into the mechanism by which tin is deposited on conductor rolls and can cause product rejections or yield loss.

3 p.m.—Break

3:30 p.m.—The Effect of Steel Substrate Surface Roughness on the Localized Corrosion Behavior of Tin-plated Steel Samples
Sridhar Ramamurthy & N.Stewart McIntyre, Surface Science Western, Western Science Centre, The University of Western Ontario, London, Ontario, Canada
Four tinplated steel samples, exhibiting varying levels of steel substrate surface roughness, were analyzed in the study using a number of surface analytical and electrochemical techniques. Secondary ion mass spectrometry (SIMS) imaging-depth profiles and Auger elemental distribution maps indicated that the extent of the surface coverage of the tin coating was controlled by the height of the rolling marks on the steel substrate. Depending on the height of the rolling marks, either the iron-tin alloy layer or the steel substrate was exposed to the outer surface. Electrochemical polarization studies suggested that, in de-aerated synthetic pear juice, the exposed regions would corrode preferentially, resulting in the localized pitting on the tinplate surface. Such occurrences of localized corrosion were also detected by the scanning reference electrode (SRE) measurements. Based on results from these measurements, it was concluded that the extent of localized corrosion was controlled by the steel substrate surface roughness that controlled the level of exposure of the iron-tin alloy and/or the steel substrate to the outer surface.

4 p.m.—Use of Advanced Surface Analytical & Electrochemical Techniques in Tinplate Corrosion Research
Sridhar Ramamurthy & N.Stewart McIntyre, Surface Science Western, Western Science Centre, The University of Western Ontario, London, Ontario, Canada
A review of the most commonly used surface analytical and electrochemical techniques and their application to tinplate research will be presented. The surface analytical techniques of interest are: X-ray photoelectron spectroscopy (XPS or ESCA), scanning Auger microscopy (SAM), static and dynamic secondary ion mass spectrometry (static and dynamic SIMS), surface profilometry, atomic force microscopy (AFM), Fourier transform infrared spectroscopy (FTIR) and laser Raman spectroscopy. In addition, a description of the most commonly used electrochemical techniques, such as electrochemical corrosion potential, electrochemical polarization, electrochemical impedance spectroscopy (EIS), coulostatic method, and, a relatively new method—scanning reference electrode/scanning impedance probe technique—will be presented. The application of these techniques to tinplate research will also be discussed. Wherever applicable, examples from the research carried out using these techniques, and their corresponding usefulness, will be discussed.

4:30 p.m.—A Synopsis of the Tin Mill Products Industry
G.W. Bush & Associates, Moon Township, PA & T.A. DeLoia, Techint Technologies
A macro-scale review of the tin mill products (TMP) industry was made to estimate the near-future requirements of that industry on a worldwide basis. About 70 percent of the world's TMP is produced in the developed countries, and almost 30 percent of the total production is from six companies. Phenolsulfonic acid processes are used for more than 70 percent of the total production; halogen processes are used for more than 20 percent of the production; and methanesulfonic acid and other processes are used for the balance of the total production. In the industrialized countries, competition from alternate packaging materials and processes and from different distribution methods will continue to erode the markets for these products. Further consolidation of the industry is expected in these geographical areas. In the developing countries, TMP are a growth industry. It is expected that a number of additional lines will be required during the next 10 years. The differing needs of these economic-geographic areas create demands for different kinds of tinpalting facilities.

Tuesday Evening, May 11
Reception Sponsored by Suppliers

Wednesday Morning, May 12
Session III—Tinplate Process & Equipment

Session Chairmen: Bruce Batdorf, Wheeling-Pittsburgh Steel, Yorkville, OH & Dr. Michael Sun, National Steel, Trenton, MI

8:30 a.m.—Sulfamic Electrolyte for Tinning—Five Years of Continuous & Successful Work
V.A. Paramonov & V. P. Vinogradov , GNC CNIIChermet, Russia & S. K. Nosov, A.V. Kushnaryov, R.I. Cherkassky & I. A. Chernyahovskaya, Magnitogorsk Integrated Steel Works, Joint Stock Co., Russia
Ecologically safe sulfamicelectrolyte has successfully worked for five years in industrial tin plating lines that have a total capacity of 665,000 t of tin plate per year. The lines are at the Magnitogorsk Integrated Steel Works (Russia) and the ISPAT-KARMET Works (Kazakhstan). This high-grade tin plate with 1.4-8.4 g/m^2-grade coating is used for food stuff can production in Russia, CIS countries, Turkey, Romania, China, Egypt and other countries. The new technology allowed the improvement of coating quality and labor conditions as well. The quality of coating improved to a high extent as compared with Ferrostan (especially in thin layers). The efficiency of tin utilization also increased because of edge-effect minimization and the growth of high-grade product output. Additional studies have made it possible to keep the process highly stable under conditions of continuous, long-time service. The stable operation of the Magnitogorsk lines was at the strip speed of up to 7 m/sec. The addition of sulfamic electrolyte for tin plating minimized slurry formation.

9 a.m.—Iron Removal from Methane Sulfonic Acid Tin Plating Solution
George A. Federman, LeaRonal Inc., Freeport, NY
Iron contamination of acidic stannous tin plating processes is known to cause a loss of plating range and an increase in the generation rate of stannic tin sludge. The design of the horizontal cell tinplate line ensures that substantial amounts of iron are dissolved into the plating bath on a daily basis, and this is especially the case with an unbuffered low pH plating process, such as the methane-sulfonic-acid-based Ronastan TP process. It is essential that some type of iron removal technology be utilized to maintain an acceptable level of iron in the plating process. Various iron removal techniques have been employed by tinplate producers in the past, but all either lose valuable tin and/or chemicals or use substantial amounts of energy. An iron removal system was developed in late 1996, and a production unit was installed on the 32-cell halogen line at National Steel's Midwest Division in March 1997. This system is highly selective for iron, recycles all non-contaminant chemicals and is energy efficient. This paper will describe the theory and practice of the iron removal system in a production environment.

9:30 a.m.—Break

10 a.m.—Development of a Trivalent Chromium ECCS Process
Richard N. Steinbicker Bethlehem Steel Corporation, Bethlehem, PA; Allen R. Jones, Atotech USA, Inc., Rock Hill, SC; John A. Sinsel, Weirton Steel Corporation, Weirton, WV; & William R. Johnson, US Steel Group, A Unit of USX (retired), Pittsburgh, PA
As reported at the Eighth Continuous Steel Strip Plating Symposium, between 1992 and 1994 the AISI Tin Mill Product Collaborative Research Board conducted a project aimed at the development of a new process for the production of electrolytically chromium-coated steel (ECCS). That project concluded that it might be possible to replace the hexavalent chromic acid electrolytes now used for depositing the metallic and nonmetallic coating layers with baths based exclusively on trivalent chromium. As a result, in 1996 a new collaborative project was started, to continue the development of the environmentally and occupationally friendly trivalent chromium process. Laboratory experimentation was focused primarily on minimizing the evolution of chlorine during the two-step (Cr^0 & CrOx) process, widening the operating windows of the nonmetallic chromium deposition and improving the appearance of the ECCS product. Two pilot line runs demonstrated varying degrees of success in attaining these objectives. Matrices of experimental coatings were produced on two different steel substrates: 65BW DR-9 and 85BW T4CA; including four levels of CrOx coating weight on three thicknesses of metallic chromium. These pilot line materials were roller-coated with appropriate lacquers and draw-redraw cans and

ends were formed from the coated panels. The resulting cans and ends were filled with a tomato product and put into accelerated pack-tests. Result of the pack tests and conclusions of other laboratory evaluations will be presented.

10:30 a.m.—An Equipment Builder's View on Tin Plate Line Design & Development
R.A.E. Hooper, Kvaerner Metals (formerly Davy International), Sheffield, England
The world market for tinplate and TFS is 15mtpa and rising a two percent pa, with TFS increasing from its current level of 10 percent. There have been approximately 160 lines built, but more than half of these entered production before 1970. The peak building period was in the 1960s, except for the Pacific Rim, which has, in the last 20 years, built more lines than the rest of the world. The recent trends feature increased line speeds; more even, higher quality and thinner coatings; increased environmental awareness; plus reduced operating and capital costs. This has led to both insoluble and novel, improved soluble anode designs. Improved coating quality and environmental benefits have been achieved with phenol-free electrolytes based on MSA and TSA. There is increased concern for conserving water and research into fluid flows by (FEA) is leading to improved cell design to minimize splash and carryover. Rinsewater and fume recovery and purification are now very important to meet increasingly tough legislation. These enhancements, together with newly developed special machines, such as tension levellers and welders, are being applied to old and new lines to improve quality, reduce costs and increase output.

11 a.m.—Covered Rolls & Their Applications
Peter A. Fellows & James I. Manore, Vail Rubber Works, Inc., St. Joseph, MI
Rolls covered with elastomeric materials are often used to transport and otherwise enhance physical characteristics of metal strips during processing operations. This paper provides an introduction to rubber, polyurethane, and nonwoven, fiber covering materials and their applications in today's steel processing mills. The paper will discuss proper techniques for maintenance, storage, packaging and shipping of rolls; the effects of chemicals and temperature on roll covers; suggestions for proper cleaning of roll covers; and alternatives in roll covering materials for difficult applications.

11:30 a.m.—Computer Simulation Model to Calculate Process Line Production
John E. Beatty, Danieli Wean, Youngstown, OH
Computer simulations have proven to be a powerful tool in the steel industry. They have been used to finalize plant layouts, analyze equipment operation and determine production performance. A mathematical model allows for the real world variability in timing. When coils are joined at the welder or parted at the exit shear, the time will typically follow a mathematical distribution. This variability cannot be factored in typical calculations or spread sheets, where either minimum, maximum or average cycle times are utilized. Most models are based on tracking discrete or unit components. This paper describes a computer simulation system designed for a continuous strip processing line. Discrete components enter the system but are processed in a continuous mode, then exit again as discrete components. The model was calibrated and verified with field-collected data. This system was developed and tested on both a hot dip galvanize line and an electroytic tin line.

12:15 p.m.—Lunch

Wednesday Afternoon, May 12

Plant Tour

USS Gary Tin Mill & Electrogalvanizing Line, Gary, IN

1:30 p.m.—Buses depart from hotel
5:30 p.m.—Buses return from hotel

Thursday Morning, May 13

Session IV—Electrogalvanized Product

Session Chairmen: Dr. Glenn Bush, Bush & Associates, Moon Township, PA & Edward Williams, Walbridge Coatings, Walbridge, OH

8 a.m.—TEM Analysis of Galvanized Steel Using the FIB Lift-out Specimen Preparation Technique
L.A. Giannuzzi, B.I. Prenitzer & J.L. Drown, Mechanical, Materials & Aerospace Engineering,

University of Central Florida, Orlando, FL; T. Shofner, The Bartech Group, Orlando, FL; & S.R. Brown, R.B. Irwin & F.A. Stevie, Cirent Semiconductor, Orlando, FL

The Fe-Zn interface (galvanized steel) is an extremely difficult material system to prepare a specimen suitable for TEM analysis. Using the FIB lift-out technique, a focused ion beam may be used to slice an electron-transparent TEM specimen from the bulk galvanized steel interface in less than five hr. The 5 um x 20 um TEM specimen is then micro-manipulated onto a carbon-coated copper TEM grid. The FIB lift-out technique will be described in detail. TEM analysis of various galvanized steel interfaces will be presented.

8:30 a.m.— Zinc/Resin Composite Plating as Chromium-free Conversion Treatment

Jacque Wijenberg & Bert van Haastrecht, Hoogovens Research & Development, The Netherlands; & Rick Hall & Fred Bakx, AKZO NOBEL Resins, The Netherlands

During electroplating, insoluble substances that are added to the plating bath can be incorporated in the deposit. The coatings obtained are often called composite coatings. In principle, all conceivable sorts of particles (ceramic, organic, etc.) can be incorporated in a metallic matrix. Because such coatings have unique functional properties, extensive research has been done in the field over the past few years. This study is aimed at the development of a zinc coating in which resin particles are embedded. The zinc/resin composite coating is applied on galvanized steel, either HDG or EG. It serves as a replacement for the chromate treatment, which is currently being employed in most coil coating lines. Chromium compounds are considered as occupational and environmental hazards. Because regulations for their use, containment and disposal are becoming more restrictive, there is a necessity to look for chromium-free treatments. Resin particles with special functional groups were synthesized. These modified particles promote cross-linking with a primer. The particles were dispersed in a zinc plating bath. From the standpoint of practical applicability, a sulfate bath was chosen, which is commonly used in strip lines. To stabilize the plating bath, a surfactant was added. From this plating bath, coatings containing a large amount of resin particles were applied on HDG at high current densities. Painted test panels were produced to enable performance tests covering both paint adhesion as well as corrosion tests. Test results look very promising. The process seems suitable for scaling up.

9 a.m.—Surface Appearance & Blackening Phenomenon of Anti-Fingerprinted Steel Sheet

Y.K. Song, II, H.J. Kim & S.K. Chang, Coating Technology & Electrical Steel Sheet Research, Team Technical Research Labs., POSCO, Republic of Korea

Anti-fingerprinted steel sheet is being used for computer cases, and inner and outer enclosures for household appliances. This sheet has to have qualities of good surface appearance and blackening resistance. The color of anti-fingerprinted steel sheet changes from white to black under high humidity conditions. This is known as the blackening phenomenon. It is known that the qualities mainly depend on the chromating treatment on the electrogalvanized steel sheet for good corrosion resistance. In this report, the chromating solution, surface appearance and blackening phenomenon were studied. The mechanism of blackening phenomenon was analyzed by SAM and ESCA technique. The diffusion and oxidation of zinc was found to be the main cause of blackening. Cl retained on the electrogalvanized steel sheet and pH content in the chromating solution should be fully removed by water rinsing and be controlled within 10 ppm, respectively. The chromating solution treatment with addition of PS additives was developed to get a good surface appearance and blackening resistance.

9:30 a.m.—Break

10 a.m.—Surface Texture of Zn-Ni Alloy Electrodeposit at High Current Density

Young Sool Jin, Tae Yeob Kim & Hyun Tae Kim, Technical Research Labs, Pohang Iron & Steel Co., Ltd., Pohang, Korea

The surface morphology and structure of Zn-Ni alloy electrodeposit were surveyed from chloride bath at high current density using a rotating cylinder electrode cell equipped with three electrodes, in which a turbulent flow can be obtained at a relatively low rotation speed. The deposited grains became smaller and more compact, as well as changed from granular to pyramidal type with increasing nickel content of the deposit from the basic electrolyte, in absence of additives. The electrolyte with complex-type additive, such as carboxylate or citrate ion, exhibited no effect of grain refinement, even though the deposition overpotential was increased, compared to the basic electrolyte. The addition of surfactant modified the deposits refined and granular, which could be related to the adsorptive effect of surfactant.

10:30 a.m.—Value-added Coatings for Electrogalvanized Steel

Kevin Wrest, Oakite Products, Inc., Berkeley Heights, NJ

For automotive applications, conventional zinc phosphate is applied at the steel mill to the EG substrate as an aid in stamping at the automotive plant. When coated with automotive-approved oil, the phosphated substrate has a reduced coefficient of friction, and the result is improved stamping, reduced die wear, and fewer part rejects. More recently, dried-in-place (DIP) phosphate has been used for the same purpose. Added benefits of the DIP process include more accurate coating weight control, less production space required at the mill, and a reduction in chemical waste. Acrylic polymer-based coatings are used on EG to protect against corrosion, prevent fingerprinting, and as a light-duty forming aid. They can also be used as a pre-paint treatment with most coil-applied paint systems. These two-component coatings (polymer and chrome) are roll-coat applied at the steel mill or on a coil coating paint line. Applications include computer chassis, appliance, general industry, and as a protective coating for overseas transport.

11 a.m.— Laboratory Modeling of Counterflow System & Application for an Industrial Line

Eric Chauveau, Stater Departs, Alain Bello & Isabelle Marolleau, Sollac-Ledepp, Florange, France

The effect of hydrodynamics in an electrodeposition cell was analyzed. The hydrodynamics of some laboratory pilots are well-known (rotating electrode with Levich's modelization), but for other pilots or industrial cells, there is no data concerning the speed of the flow of electrolyte in the gap between the strip and the anode. Some guidelines will be presented on limiting current density, macrothrowing power of a bath, and Nernst layer. Our laboratory cell for hydrodynamics will be presented, as well as the method of determination of the flow speed. The effect of some major parameters for the counterflow system will be analyzed, such as diameter of injectors and strip speed. Some elements will be presented on a mathematical modelization of hydrodynamics in an industrial cell. In conclusion, some results will be presented on the effect of hydrodynamics on the morphology of a zinc deposit (rugosity and dendritic growth on the strip edges).

11:30 a.m.—Corrosion Inhibitors in Production & Plating of Steel Strips

U. Etzold & K.P. Mohr, Thyssen Krupp Stahl AG, Duisburg, Germany; & P. Hulser, SurTec GmbH, Trebur, Germany

Corrosion inhibitors are used in the steel industry in different processes for the production and plating of steel strips. They are used in pickling baths for descaling after hot rolling or in pickling baths that are located between an alkaline cleaning section and the electrolytic cells in the plating processes, for example. Different inhibitors are required for sulfuric and hydrochloric acid pickling. The effects of corrosion inhibitors in a pickling bath before a zxinc plating process were studied in detail. Relatively low inhibitor concentrations protected steel surfaces from excessive etching effects in both sulfuric and hydrochloric acid baths. The use of these inhibitors did not affect the properties of the zinc-coated products or the subsequent surface treatment of them. These inhibitors increased the lifetime of both pickling baths and protected the steel surface during one-side plating from discoloration. By selecting the right inhibitor, hydrogen diffusion into the metal, causing hydrogen embrittlement, can be reduced. To achieve a constant product quality, a regular analysis of the inhibitor concentration in the pickling bath is necessary. This can be done via HPLC analysis or via measuring the weight losses of test coupons during pickling.

Noon—Modelling Lead Removal in an Electrogalvanizing Process by Means of Strontium Carbonate Addition

Johann Botha & Peter Levey, Itec R&D, ISCOR Ltd., Gauteng, South Africa

The dynamic behavior of strontium carbonate ($SrCO_3$) additions to acidic sulfate electrolytes to lower lead (Pb) solubility was modelled. The analytical model, which can account for electrolyte composition, bath mixing, sources and sinks

of lead in the system, was developed using computational fluid dynamics (CFD) and laboratory experimentation. The model was validated by means of an industrial line trial.

12:45 p.m.—Lunch on your own

Thursday Afternoon, May 13

Plant Tour

Ford—Chicago Heights Stamping Plant

Chicago Heights, IL

(Register early; tour limited to 50 people)

3 p.m.—Buses depart from hotel

6:30 p.m.—Bus returns to hotel

Friday Morning, May 14

Plant Tour

National Steel's Midwest Tin Mill

Portage, IN

(Register early; tour limited to 50 people)

8 a.m.—Bus departs from hotel

12:30 p.m.—Bus returns to hotel

Hotel Information

Hotel accommodations are not included with the symposium registration fees. Please make your reservations directly to the Hyatt Regency Chicago (FAX 312/616-6838). Your reservation form must be received by the hotel no later than Saturday, April 3, 1999.

For More Information

American Electroplaters and Surface Finishers Society, Attention: Educational Services Department
12644 Research Parkway
Orlando, FL 32826-3298
Phone 407/281-6441
FAX 407/281-6446
e-mail: education@aesf.org

On-site Registration Hours

Monday, May 10 ..... 9 a.m.–3 p.m.
Tuesday, May 11 ..... 7 a.m.–5 p.m.
Wednesday, May 12 ..... 7 a.m.–2 p.m.
Thursday, May 13 ..... 7 a.m.–3 p.m.
Friday, May 14 ..... 7–9 a.m.

Plant Tour Information

Monday, May 10

Metro Metals, East Chicago, IN

Noon—Buses depart from hotel

5:30 p.m.—Buses return to hotel

Metro Metals' new 72-in.-wide electrogalvanizating line began operation in early 1997. The line made use of many of A/K Steel's No. 1 electrogalvanizing line components, along with five newly designed, horizontal plating cells, with a total plating current capacity of 230,000 A replacing the old vertical plating cells. The line makes 10/10 to 60/60 g/m^2 coatings, with the capability to apply a phosphate and/or chromate post treatment.

LTV Tin Mill, Indiana Harbor, IN

LTV Corporation's Indiana Harbor tin line is a major producer of electrolytic tin plate and tin-free steel (ECCS) products. The tin plating line utilizes the halogen electrotinning process to produce 280,000 t/yr of up to 38-in. wide coated steel sheets. The line plates on both sides of the strip as it is processed through two tiers of horizontal plating cells, at speeds of up to 1800 ft/min. The first tier has 18 cells; the second has 14. All cells are 9,000 A. On the third tier, the strip passes through reclaim and rinse tanks, then is fluxed, dried and marked before passing through the reflow tower that gives the coated strip the shiny finish preferred by most customers. The molten tin on the strip is solidified in water in the quench tank directly under the tower. The strip then passes through the passivation treatment section, where it is given either a cathodic or a dip treatment in an acidic sodium dichromate solution. The final step is application of very light ATBC or DOS oils using an electrostatic oiler prior to being coiled on one of two delivery tension reels. The mill has the capability of making a full range of tin-plated products, including differential, bright, matte, passivated, dry and oiled tin plate in the coating weight range of 0.05–1.25 lb/BB (1.12–218 g/m^2).

Wednesday, May 12

USS Gary Tin Mill, Gary, IN

1:30 p.m.—Buses depart from hotel

5:30 p.m.—Buses return to hotel

Steel used in food and beverage containers, aerosol cans, paint cans and pails is finished in the Tin Prodcts Division area of Gary Works, U.S. Steel. Hot-rolled and pickled strip is reduced in thickness on a six-stand cold reduction mill and then electrolytically cleaned. The steel is then continuously annealed or electrolytically cleaned and batch-annealed to soften it before it is electrolytically coated with tin or shipped as "black plate" to the customer. The strip is temper-rolled or double-cold-reduced before coating. Gary has two USS-type electrotinning lines that use phenol-sulfonic-acid- (PSA) based electrolyte.

USS Gary No. 1 Electrogalvanizing Line, Gary, IN

The No. 1 Electrogalvanizing Line at Gary Works started operation in April 1977, and is the world's first dedicated automotive EGL facility. It uses the CAROSEL® process that was developed by USS Research and is capable of running 65-in. wide (maximum) strip with 285,000 tons of annual capacity. The line was designed originally for one-side-coated product . It has 18 plating cells and was converted to a two-sided configuration in 1992 with a 9/9 arrangement.

Thursday, May 13

Ford—Chicago Heights Stamping Plant, Chicago Heights, IL

(Register early; tour limited to 50 people)

3 p.m.—Bus departs from hotel

6:30 p.m.—Bus returns to hotel

The Ford Chicago Heights Stamping Plant consists of 2.5 million sq ft (56 acres) under one roof. The tour will demonstrate how the plant transforms 291,000 tons of coiled steel products (including a large quantity of electrogalvanized sheet) and 11,000 tons of aluminum into major components for eight vehicle lines. In addition, smaller items are made for virtually every vehicle line made by Ford Motor Company. There are 25 major press lines, including two of the largest transfer presses in the world.

Friday, May 14

National Steel's Midwest Tin Mill Portage, IN

(Register early; tour limited to 50 people)

8 a.m.—Bus departs from hotel

12:30 p.m.—Buses return to hotel

The electrolytic tinning line (ETL) at the Midwest Division of National Steel was the first horizontal commercial electrotinning line in the world to convert to the MSA process. The ETL is similar in design to all halogen plating lines built during the early 1960s, with an annual production of 350,000 tons. It is equipped with both entry and delivery looping towers, a four-section, fully inductive reflow furnace, and 32 plating cells, each supplied by a 9,000 A, 20-V rectifier. In January 1996, National Steel installed the MSA electrolyte in the Midwest Division ETL to reduce sludge formation and environmental concerns. The new plating process required additional equipment in order to operate in the halogen line design. Specifically, equipment requirements were: Vacuum evaporator, insoluble anode, filtration system, iron removal system, and eight-stage countercurrent rinse system.

Safety Note for All Tours

For safety reasons, closed-toe shoes are required for all the tours. In addition, for the National Steel Midwest Tour, long-sleeved shirts are required.

1999 Continuous Steel Strip Symposium Registration Form

Must be accompanied by payment • Register early! On-site fees apply after 4/3/99.

General Information (please print clearly). Please fill out entire form. Payment must accompany form.

AESF Member Number

Name First Middle or Initial Last

❑ *Please check here if you require special accommodations to participate fully. Attach a written description of needs.*

Office Telephone (please include your area code) FAX

Title CEF?

Company

Company Address (P.O. Box or Street)

Company Address Continued

City State/Country

Mail/Zip Code E-mail Address

Registration Policies

If you cancel a registration more than 15 working days before the start of the educational program, you will receive a full refund. Registrations cancelled thereafter will be subject to a $50 service charge. Registrants who do not attend and do not notify AESF prior to the program will be charged the entire fee. Telephone and FAX registrations are subject to the same policy. Membership in the AESF is on an individual basis. If you, personally, are not a member, please pay the Non-Member rate. If your registration or payment is received by AESF after April 3, 1999, your credentials/receipt will not be mailed. Instead, they will be held for you at the AESF Registration Desk. Payment of registration fee conveys right to attend only. No video taping or recording allowed. AESF shall not be liable beyond the refund of the registration fee. No on-site refunds of registration fees will be made. Contact Headquarters in writing for all adjustments. Circumstances may make it necessary to cancel a program or to substitute other qualified speakers. Please consider this when arranging transportation, as AESF cannot assume responsibility for non-refundable tickets. If the program is not held, for any reason, the liability of the AESF is limited to a refund of the registration fee.

1. I wish to become an AESF member and register at the member rate! *NON-REFUNDABLE*

❑ 90 AESF Member Dues $85 *(price reflects annual dues and $5 application fee)* $90 _____

2. I wish to renew my AESF member dues! *NON-REFUNDABLE*

❑ 70 AESF Member Dues renewal $85 $85 _____

3. I wish to register for the following:

	Before April 3		After April 3		
	Member	Non-member	Member	Non-member	
❑ CS99-01 Continuous Steel Strip Symposium, May 11–13	$245	$285	$255	$295	____
❑ CS99-02 Plant Tours—Metro Metals Electrogalvanizing Line, & LTV Tin Mill, May 10	$10	$10	n/a	n/a	____
❑ CS99-03 Plant Tour—USS Gary Tin Mill Electrogalvanizing Line, May 12	$10	$10	n/a	n/a	____
❑ CS99-04 Plant Tour—Ford Chicago Heights, May 13 (Limit 50)	$10	$10	n/a	n/a	____
❑ CS99-05 Plant Tour—National Steel Midwest Tin Mill, May 14 (Limit 50)	$10	$10	n/a	n/a	____

TOTAL ____

4. Method of payment

❑ Enclosed is my check or money order #_____, in U.S. funds drawn on a U.S. bank, payable to AESF.

❑ Charge to my credit card: ❑ MasterCard ❑ VISA ❑ American Express

Expiration Date: ____ / ____

_____

Account Number

_____

Print Name on Card

_____

Signature *(name on credit card)*

Note: *Registration will not be processed until payment is received.*

Three Ways to Register!

1. **Mail to**
   12644 Research Parkway
   Orlando, FL 32826-3298

2. **Call in your registration**
   407/281-6441
   (by credit card)

3. **FAX form to**
   407/281-6446
   (by credit card)