DCS

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Participation in Materials Week '92 Conference sponsored by ASM and TMS (20-5704-041)

DATE AND PLACE: November 2 - 4, 1992
Chicago, Illinois

AUTHOR: Narasi Sridhar

DISTRIBUTION:

CNWRA	NRC-NMSS	NRC-RES	SwRI
J. Latz	M. Knapp	F. Costanzi	S. Rowe (SwRI Contracts)
W. Patrick	W. Brown	B. Morris	
Directors	B. Stiltenpole	M. Silberberg	
Element Managers	B. Meehan	M. McNeil	
J. Walton	J. Youngblood	J. Randall	
H. Manaktala	J. Linehan		
E. Tschoepe	R. Ballard		
G. Cragnolino	R. Weller		
	C. Interrante		
	K. Chang		
	T. Ahn		

210077

9212220101 921124
PDR WASTE
WM-11 PDR

426.1
WM-11
NH15

delete all distribution except: CF, ASL & NRDOCS

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Participation in Materials Week '92 Conference sponsored by ASM and TMS (20-5704-041)

DATE AND PLACE: November 2 - 4, 1992
Chicago, Illinois

AUTHOR: Narasi Sridhar

BACKGROUND AND PURPOSE OF TRIP:

Material Week '92 is the annual materials conference and exhibition jointly sponsored by ASM International and The Minerals, Metals and Materials society (TMS). The author was invited to give a talk in the symposium on Joining Impact on Design. No written paper is required for this symposium. Other symposia of potential interest to the waste package program included Interfacial Segregation, Environmental Effects and Wear Phenomena, and Sensors and Actuators for Adaptive Materials.

SUMMARY OF SALIENT POINTS AND ACTIVITIES:

A program at a glance is attached (Attachment A). Because of the concurrent sessions, the author could not attend all the papers of interest on any given day. A copy of the viewgraphs presented by the author in the joining symposium is also attached (Attachment B). Unfortunately, many of the talks emphasized the weld procedure aspects more than fundamental issues related to design of weldments for corrosion resistance. There also seems to be dirth of systematic research in the area of weld metal chemistry and corrosion resistance. As an example of the stagnation in the field, three presenters (including the author) referred to a single investigation (by Cieslak et al. at Sandia) of weld metal segregation in Ni-base alloys. The joining committee is searching for ways to incorporate welding as a consideration in the development of new alloys or components prior to the occurrence of various weld related problems. Papers on interfacial segregation dealt with both modeling and experimental aspects. Interfacial segregation may be a factor in the performance of candidate container materials as a result of long-term, low-temperature exposure. From the experimental point of view, interfacial analysis by Z-contrast scanning transmission electron microscopy (STEM) was especially interesting. An overview paper by M. F. Chisholm and S. J. Pennycook (ORNL) on the Z-contrast technique presented the advantages of this technique in interfacial analysis. The technique employs a convergent electron beam to probe the specimen and analyzes the

Rutherford scattering which is dependent on the atomic number (Z) of the scattering atoms. The resultant image is representative of the direct position of the atoms of selected Z value rather than a diffraction pattern as in conventional TEM. The symposium on remote sensors for monitoring material degradation essentially dealt with sensors for detecting mechanical loading and failure conditions. The one paper dealing with corrosion sensors on board aircrafts discussed employing optical fibers coated with Al which were calibrated against aircraft structural materials in laboratory salt-fog type tests. As the Al coating deteriorated, changes in the refractive index of the fibers were detected.

Discussions were held with Dr. John Lippold of Edison Welding Institute (EWI) on friction welding. It was emphasized that at this time there is some uncertainty as to the actual design of containers although alloy 825 is still expected to play a significant role. Even if alloy 825 is used as a loose inner liner, John Lippold felt that friction/inertia welding is a good technique capable of remote operation and producing reproducible welds. The welding program envisaged within the IWPE program is small and preliminary in nature and is meant to explore the type of microstructures produced in alloy 825 by friction welding. Some preliminary electrochemical tests are also anticipated. John felt that the main concern is the scaling of the laboratory weldments to actual container size. This has to be carefully thought out. We decided to map out a strategy by January of the number and type of specimens and cost of fabricating the same.

The exhibition included booths from several national laboratories (LLNL, LANL, ORNL) and contract research labs (Battlelle, EWI, SRI).

PROBLEMS ENCOUNTERED:

None

PENDING ACTIONS:

Formulate a plan of research for the friction welding program involving the type of specimens, number of specimens, type of tests, and the cost of fabricating the specimens by Edison Welding Institute.

RECOMMENDATIONS:

The conference was not of great direct benefit to HLW program. However, discussions on the issue pertaining to welding, interfacial segregation, and remote monitoring of structures and components were beneficial.

SIGNATURE:

Narasi Sridhar
Senior Research Engineer

11/24/92
Date

CONCURRENCE:

Prasad Nair
Element Manager

11/24/92
Date

Budhi Sagar
Technical Director

11/24/92
Date

Attachments

ATTACHMENT A

MATERIALS WEEK '92 PROGRAM AT A GLANCE

MATERIALS WEEK PROGRAM AT A GLANCE

Note: For your convenience, each section is numbered and individual programs are offered in order, starting in the technical programming in which they appear. Page numbers correspond to the actual location of program information.

	See Page	Mon A.M.	Mon P.M.	Tues A.M.	Tues P.M.	Wed A.M.	Wed P.M.	Thur A.M.	Thur P.M.	Fri. A.M.	Fri. P.M.
[illegible]											
A. Processing of Metal-Matrix Composites, Gold Coast (Concourse Level W)	11										
B. Machining of Composite Materials, Hong Kong (Ballroom Level W)	13										
C. Tribology of Composite Materials, Regency Ballroom D (Ballroom Level W)	14										
D. Coatings for Composites & Composite Structures, Columbus G South (Ballroom Level E)	14										
E. 8th Annual ASM/ESD Advanced Composites Conference	110										
F. Principles of Solidification of Cast Composites, Acapulco (Ballroom Level W)	72										
G. Environmental Effects on Intermetallics, Ceramics and Composites, Regency D (Ballroom Level W)	39										
H. Metal Matrix Composites, Columbus B (Ballroom Level E)	15										
[illegible] Electronic, Magnetic & Photonic Materials											
A. The Third Form of Carbon: Fullerenes Properties & Prospects, Grand Ballroom D North (Ballroom Level E)	16										
B. Interfacial Segregation, Acapulco (Ballroom Level W)	18										
C. Diffusion in Ordered Alloys & Intermetallic Compounds, Belmont (Concourse Level W)	20										
D. Beam Processing of Advanced Materials, Columbus C & D (Ballroom Level E)	23										
E. Low Thermal Expansion Alloys and Composites, Toronto (Ballroom Level W)	28										
F. Thermodynamics & Phase Equilibria in Electronic Materials, McCormick (Third Level)	29										
G. High Temperature Superconducting Compounds: Processes & Related Properties, Columbus H (Ballroom Level E)	31										
[illegible]											
A. High-Temperature Corrosion and Erosion in Energy Conversion Systems, Columbus G South (Ballroom Level E)	33										
B. Materials for Alternatively-Fueled Engines, Columbian (Concourse Level W)	34										
C. Robert I. Jaffee Memorial Symposium on Clean Materials Technology, Columbus K & L South (Ballroom Level E)	34										
[illegible]											
A. Damping of Multiphase Inorganic Materials, Water Tower (Concourse Level W)	36										
B. Processing of Metal-Matrix Composites, Gold Coast (Concourse Level W)	11										
C. Applications of Pressure in Materials Processing, Regency Ballroom A (Ballroom Level W)	37										
D. Development of Microstructure and Texture in Materials for Electronic Applications, Regency Ballroom B (Ballroom Level W)	38										
E. Diffusion in Ordered Alloys and Intermetallic Compounds, Belmont (Concourse Level W)	20										
F. Interfacial Segregation, Acapulco (Ballroom Level W)	18										
G. Environmental Effects on Intermetallics, Ceramics & Composites, Regency D (Ballroom Level W)	39										
H. Thermodynamics & Phase Equilibria of Electronic Materials, McCormick (Third Level)	29										
I. Sensors & Actuators for Adaptive Materials, Haymarket (Concourse Level W)	42										
J. Microstructures & Mechanical Properties of Aging Materials, Columbus I & J (Ballroom Level E)	43										
K. Physical Metallurgy of Direct-Quenched Steels, San Francisco (Ballroom Level W)	51										
L. Environmental Effects & Wear Phenomena, Columbus B (Ballroom Level E)	54										
M. Phase Transformations & Structural Evolution, Columbus B (Ballroom Level E)	55										
N. Fatigue, Atlanta (Ballroom Level W)	58										
O. Deformation of Intermetallic Compounds, Regency C (Ballroom Level W)	59										
P. Structure Properties of Titanium & Aluminides, Regency C (Ballroom Level W)	60										
Q. Solidification, Gold Coast (Concourse Level W)	61										
R. Fracture, Burnham (Third Level)	61										
[illegible] Materials Design & Manufacturing											
A. Computational & Numerical Techniques in Powder Metallurgy, Hong Kong (Ballroom Level W)	62										
B. Materials Issues in Machining, Hong Kong (Ballroom Level W)	64										
C. Concurrent Engineering Approach to Materials Processing, Wrigley (Concourse Level W)	64										
D. Advances in Superplasticity & Superplastic Forming, Columbian (Concourse Level W)	68										
E. Microstructural Design by Solidification Processing, Columbian (Concourse Level W)	70										
F. Principles of Solidification of Cast Composites, Acapulco (Ballroom Level W)	72										
SECTION [illegible] Materials Shaping Technology											
A. Machining of Composite Materials, Hong Kong (Ballroom Level W)	13										
B. Processing, Microstructure and Property Relationships in Advanced PM Processes & Materials, Burnham (Third Level E)	73										
C. Materials Issues in Machining, Hong Kong (Ballroom Level W)	64										
SECTION [illegible] Materials Testing & Quality Control											
A. Failure Analysis, Atalanta (Ballroom Level W)	74										
B. Advanced Mechanical Testing: Methods & Applications, Haymarket (Concourse Level W)	75										
C. Materials Characterization Using Image Analysis, Du Sable (Third Level W)	75										
D. Metallographic IMS/ASM Contest Winners, Regency Ballroom D (Ballroom Level W)	75										
E. Workshop on Materials Characterization Using Image Analysis, Du Sable (Third Level W)	75										
F. Quantitative Materials Characterization, Regency Ballroom C (Ballroom Level W)	76										
G. Structure Characterization, Toronto (Ballroom Level W)	76										

9 SECTION - Specialty Materials						
Hard & Soft Magnetic Materials, Regency Ballroom C (Ballroom Level W)	77					
High Temperature Materials & Applications in Ground Transportation Systems, Field (Third Level W)	78					
Tribology of Composite Materials, Regency Ballroom D (Ballroom Level W)	14					
High Manganese Austenitic Stainless Steels, Wrigley (Concourse Level W)	78					
10 SECTION - Structural Materials & Processing						
6th International Conference on Surface Modification Technologies, Columbus E & F (Ballroom Level E)	79					
Beam Processing of Advanced Materials, Columbus C & D (Ballroom Level E)	23					
The Third Form of Carbon: Fullerenes Properties & Prospects, Grand Ballroom D North (Ballroom Level E)	16					
Damping of Multiphase Inorganic Materials, Water Tower (Concourse Level W)	36					
Environmental Effects on Intermetallics, Ceramics & Composites, Regency D (Ballroom Level W)	39					
Physical Metallurgy of Direct-Quenched Steels, San Francisco (Ballroom Level W)	51					
Microstructures & Mechanical Properties of Aging Materials, Columbus I & J (Ballroom Level E)	43					
Aluminum Alloys for Packaging, Grand Ballroom D (Ballroom Level E)	85					
Modeling of Coarsening and Grain Growth, Grand Ballroom D (Ballroom Level E)	88					
Low Thermal Expansion Alloys & Composites, Toronto (Ballroom Level W)	28					
Processing, Fabrication & Manufacturing of Adv. Materials for High Temp. Applications, New Orleans (Ballroom Level W)	92					
High Temperature Superconducting Compounds: Processing & Related Properties, Columbus H (Ballroom Level E)	31					
Deformation, Columbus A (Ballroom Level E)	96					
Deformation & Fracture of Ferrous Alloys, Columbus A (Ballroom Level E)	97					
11 SECTION - Surface Engineering						
Coatings for Composites and Composite Structures, Columbus G South (Ballroom Level E)	14					
Friction and Wear, Columbus G South (Ballroom Level E)	98					
Surface Cleaning & Environmental Issues, Columbus G South (Ballroom Level E)	99					
2nd Annual ASM/ESD Advanced Coatings Technology Conference	110					
6th International Conference on Surface Modification Technologies, Columbus E & F (Ballroom Level E)	79					
Powder Process & Coat & Thin Films, Field (Third Level)	99					
12 SECTION - Technology Transfer						
Technology Transfer Introduction and Plenary, Columbus K & L South (Ballroom Level E)	100					
National Consortia, Columbus A North (Ballroom Level E)	100					
Collaboration Efforts/Regional, Columbus A North (Ballroom Level E)	100					
Government/Industry Collaboration, Columbus A North (Ballroom Level E)	100					
NSF/Pilot Center, Columbus A North (Ballroom Level E)	100					
Bridging the Gap Between Science and Application, Columbus A North (Ballroom Level E)	101					
Insight into Materials Technology Transfer in DoD, Columbus K & L South (Ballroom Level E)	101					
Insight into Materials Technology Transfer in DoE, Columbus A North (Ballroom Level E)	101					
Insight into Engineered Materials Technology Transfer in DoI/BOM, Columbus K & L South (Ballroom Level E)	101					
Enabling Mechanisms for Partnerships and Technology Transfer, Columbus K & L South (Ballroom Level E)	101					
[illegible] Ballroom Level W)	[illegible]					
[illegible] Columbus H South [illegible]	[illegible]					
[illegible]	[illegible]					
SPECIAL EVENTS DURING MATERIALS WEEK						
ASM Annual Meeting	7					
ASM Awards & Annual Dinner	7					
ASM Committee/Council & Canada/Europe Awards Luncheon	7					
ASM Edward DeMille Campbell Memorial Lecture	7					
ASM & TMS Distinguished Lectureship in Materials & Society	7					
Alpha Sigma Mu Lecture	7					
TMS Student/Faculty Mixer (Sunday)	7					
TMS Career Forum (Sunday)	7					
EDUCATION COURSES DURING MATERIALS WEEK						
Total Quality Management: Effective Quality Improvement Tools	109					
Adhesive Bonding Technology in Advanced Applications	109					
Titanium-Based Advanced Materials and Titanium Matrix Composites	109					
Failure Analysis: Emphasis on Ferrous Structures and Machine Components	109					
Failure Analysis: Preventing Wear, Corrosion, and Fatigue Failures in Rotating Equipment & Machine Components	109					
Laboratory Quality Assurance: Accreditation	109					
Principles of Statistical Process Control in Heat Treating	109					
Mechanical Testing of Composite Materials: Generation of Engineering Design Data	110					
ISO 9000 and its Implication for Your Company	110					
NADCAP: Implications of Third Party Accreditation for Your Organization	110					

ATTACHMENT B

VIEWGRAPHS PRESENTED BY N. SRIDHAR AT THE JOINING SYMPOSIUM

EFFECTS OF WELDING ON THE CORROSION RESISTANCE OF SOLID SOLUTION STRENGTHENED Ni-BASE ALLOYS

Narasi Sridhar
Center for Nuclear Waste Regulatory Analyses
Southwest Research Institute
San Antonio

Joining Impact on Design
ASM Materials Week
November 3, 1992

OUTLINE

1. HISTORICAL PERSPECTIVE

2. LOCALIZED CORROSION OF Ni-Fe-Cr-Mo ALLOYS

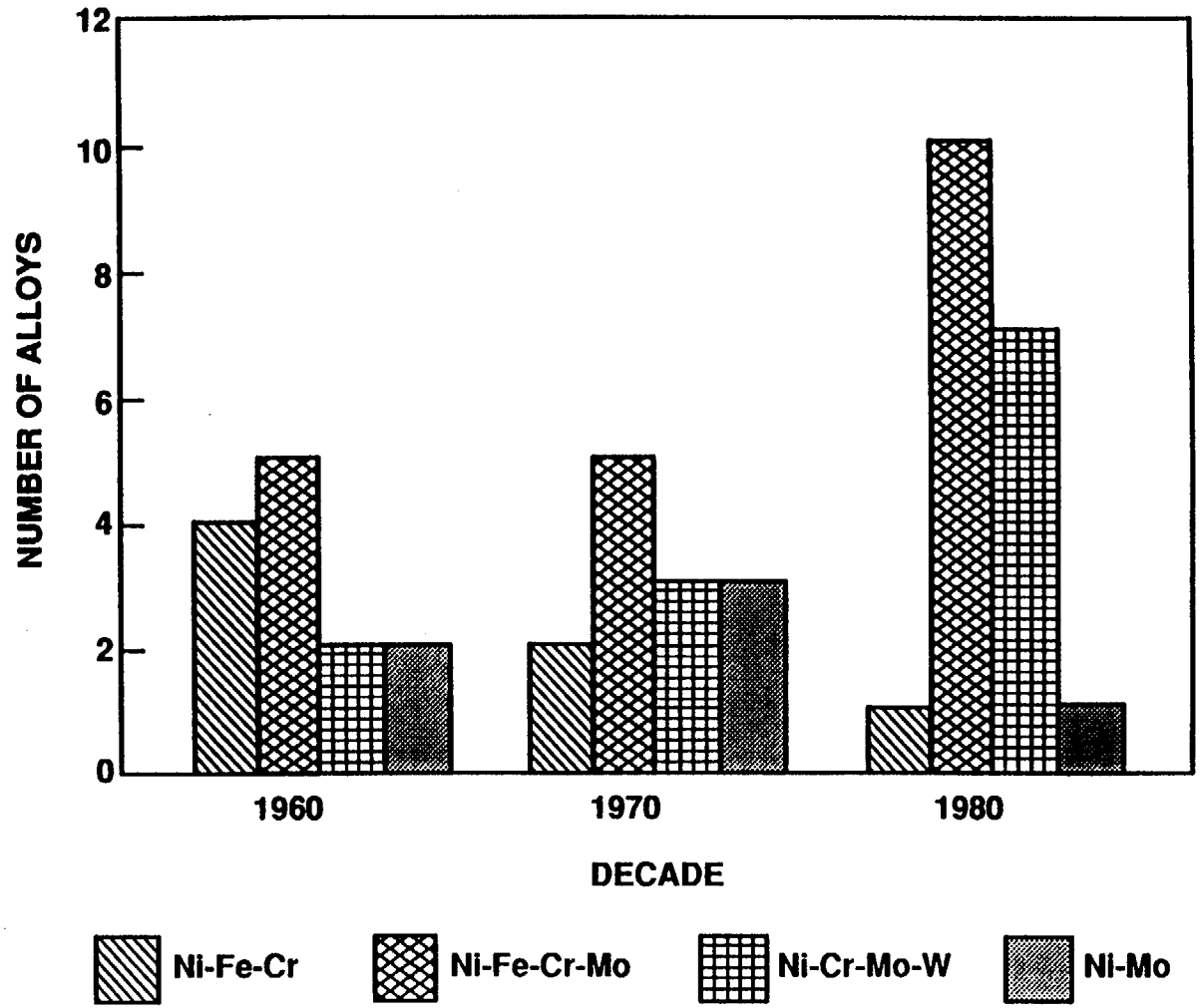
   EFFECT OF WELDING PARAMETERS
   ENVIRONMENT/TEST CONSIDERATIONS
   OVERALLOYED FILLER METALS
   POST-WELD ANNEALING/STRESS RELIEF

4. FUTURE DEVELOPMENTS

   UNDERSTANDING WELD METAL MICROSTRUCTURE AND CHEMISTRY
   EFFECT OF WELDING ON UNMIXED ZONES
   OTHER WELDING TECHNIQUES

5. SUMMARY

NEW ALLOYS COMMERCIALIZED FOR CORROSION APPLICATIONS



HISTORICAL BACKGROUND

- PRIOR TO ABOUT 1980 EMPHASIS WAS ON HAZ CORROSION

  ALLOY CHEMISTRY - HIGHER CARBON INTRODUCED CARBIDES
  INTERMETALLIC PPT. IN SOME ALLOYS (G, C-276, AL-6X)

- RECOMMENDATIONS INCLUDED

  LOW HEAT INPUT WELDING, CONTROL INTERPASS TEMPERATURE

  FILLER METAL CHEMISTRY MAINLY FOR WELDABILITY (HOT CRACKING, FLUIDITY ETC.)

  POST-WELD SOLUTION ANNEALING IN SOME CASES

HISTORICAL BACKGROUND

- AFTER ABOUT 1980 EMPHASIS HAS SHIFTED TO FUSION ZONE CORROSION

  ALLOY MODIFICATIONS RESULTED IN LESS SENSITIZATION

  MORE SEVERE APPLICATIONS PUSHING LIMITS OF BASE METAL (Eg. FGD)

- HAZ STRESS CORROSION CRACKING IS IMPORTANT IN SOME ALLOY-ENVIRONMENT SYSTEMS (Eg. Ni-Mo ALLOYS)

- RECOMMENDATIONS

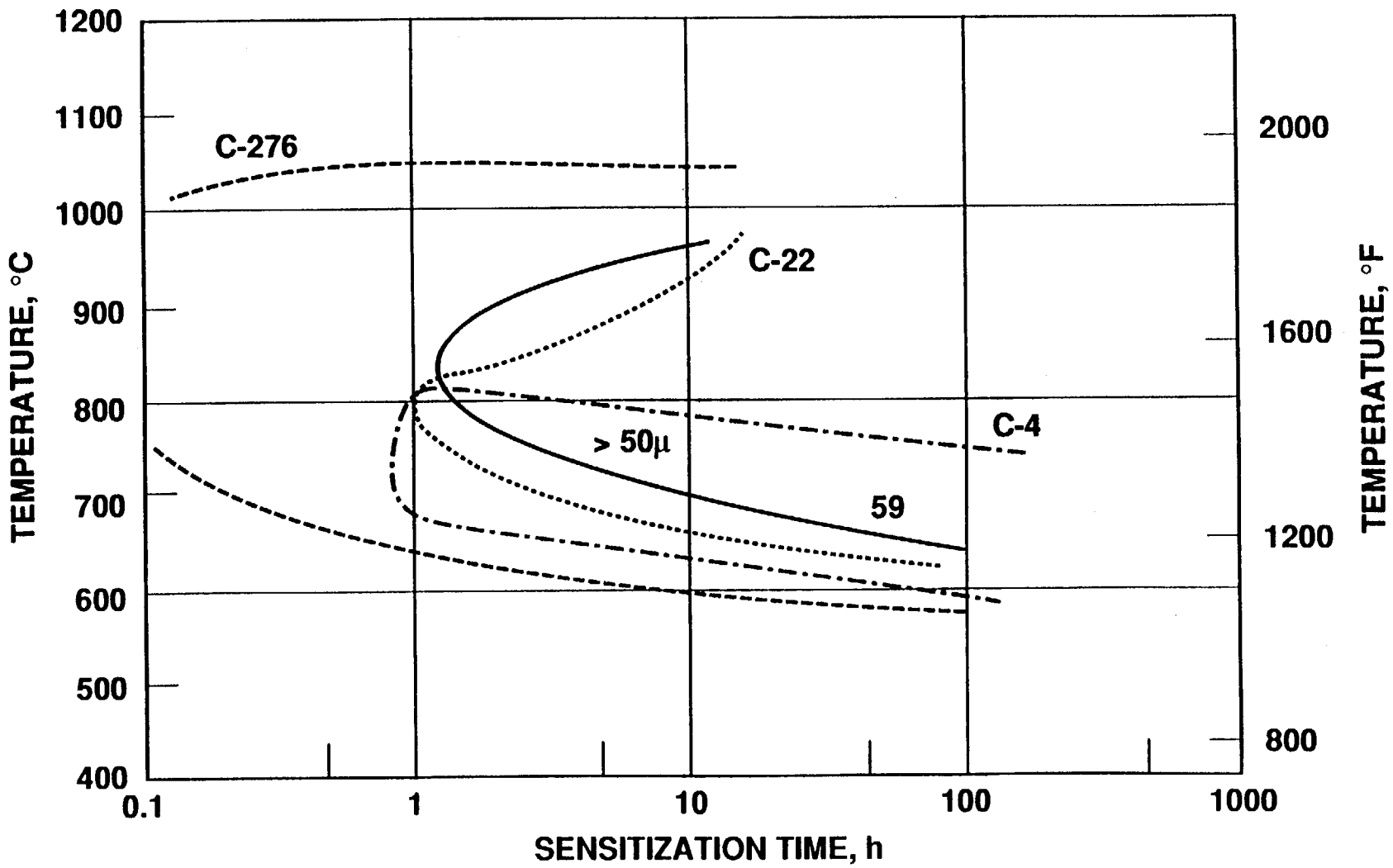
  NO AGREEMENT ON THE EFFECT OF HEAT INPUT IN THE LITERATURE

  ENHANCED FILLER METAL CHEMISTRY FOR CORROSION RESISTANCE

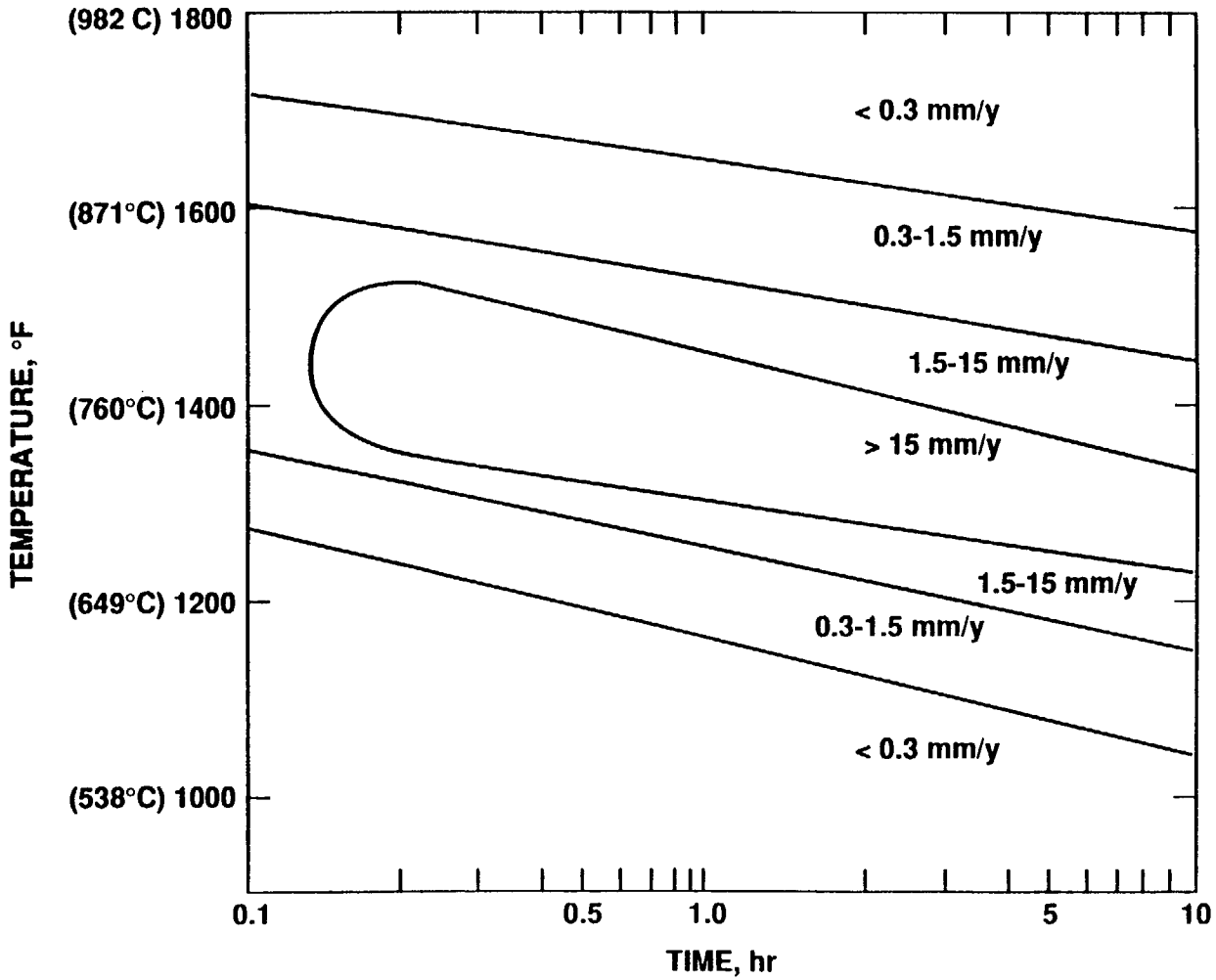
  USE OF NITROGEN-ARGON COVER GAS BENEFICIAL IN SOME ALLOYS

SENSITIZATION

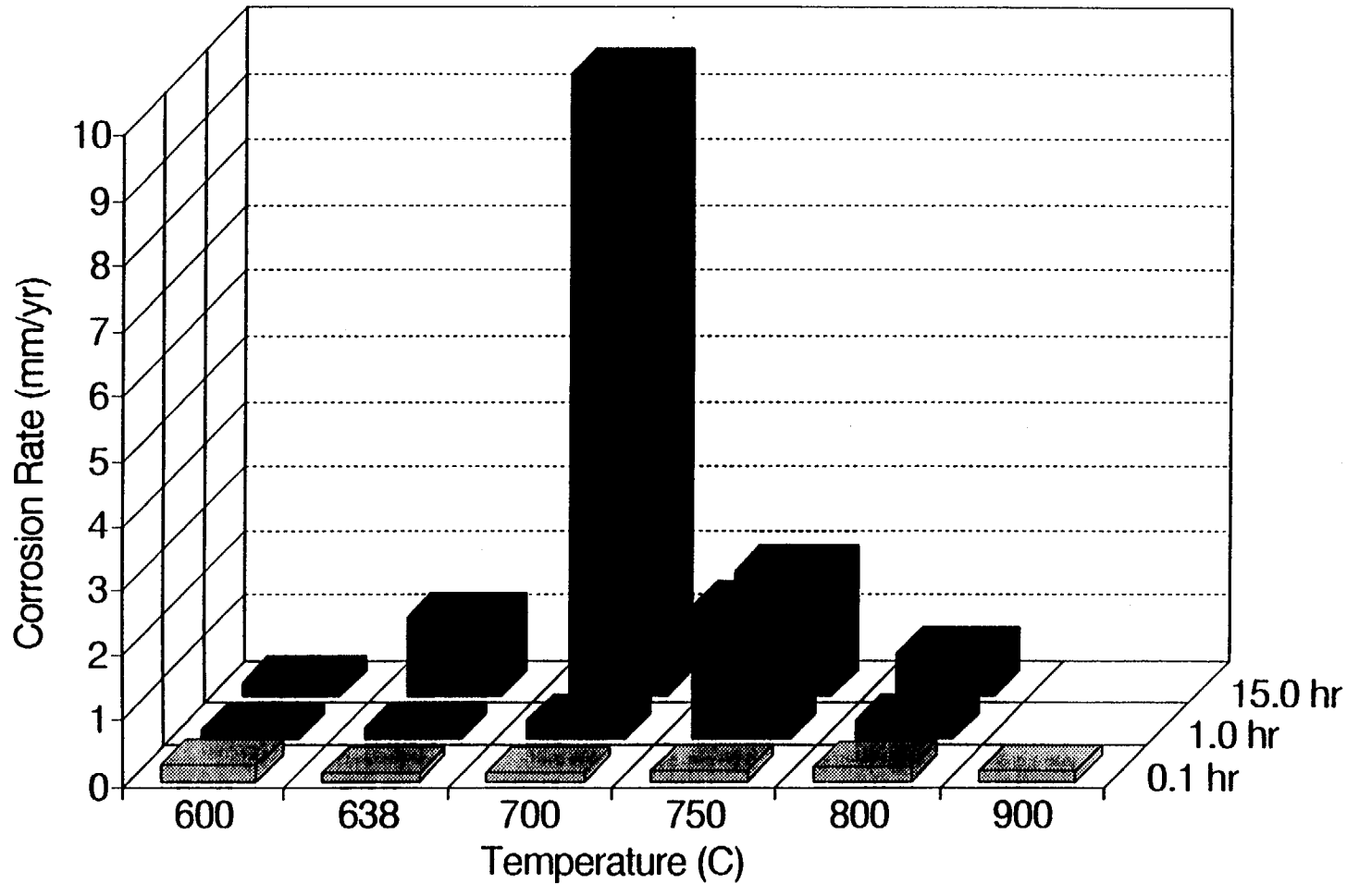
Ni-Cr-Mo-W ALLOYS, ASTM G-28A TEST (VDM DATA)



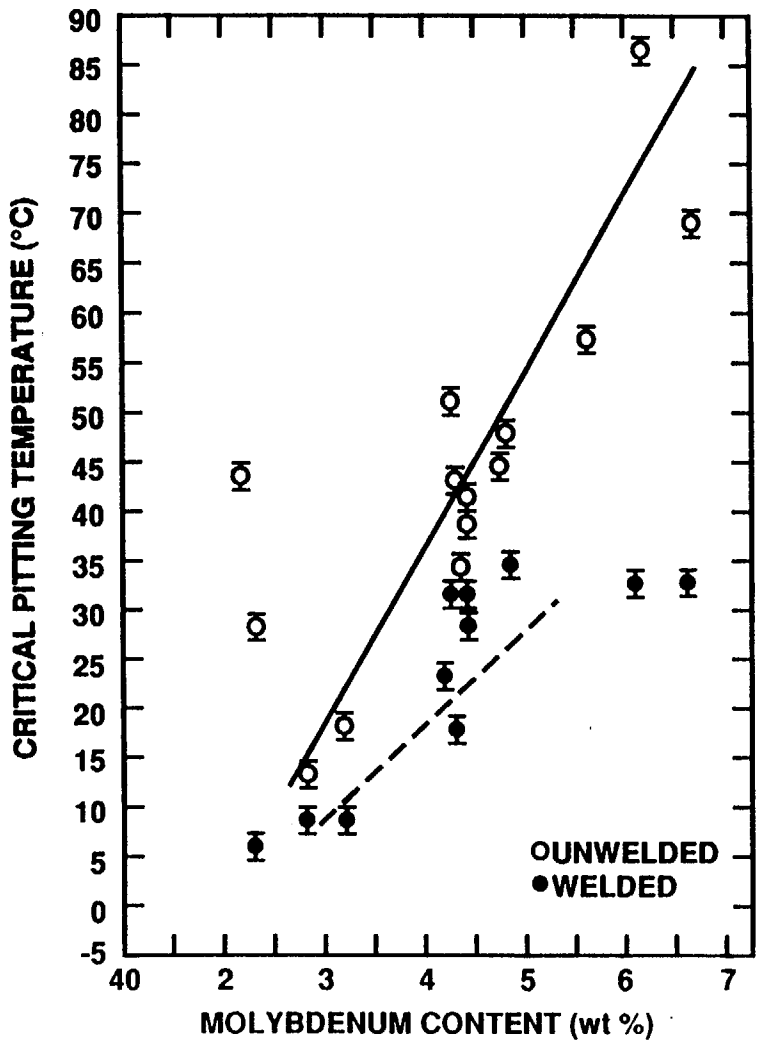
SENSITIZATION OF ALLOY 825 - OLD HEAT



SENSITIZATION OF INCOLOY 825
Solution Annealed

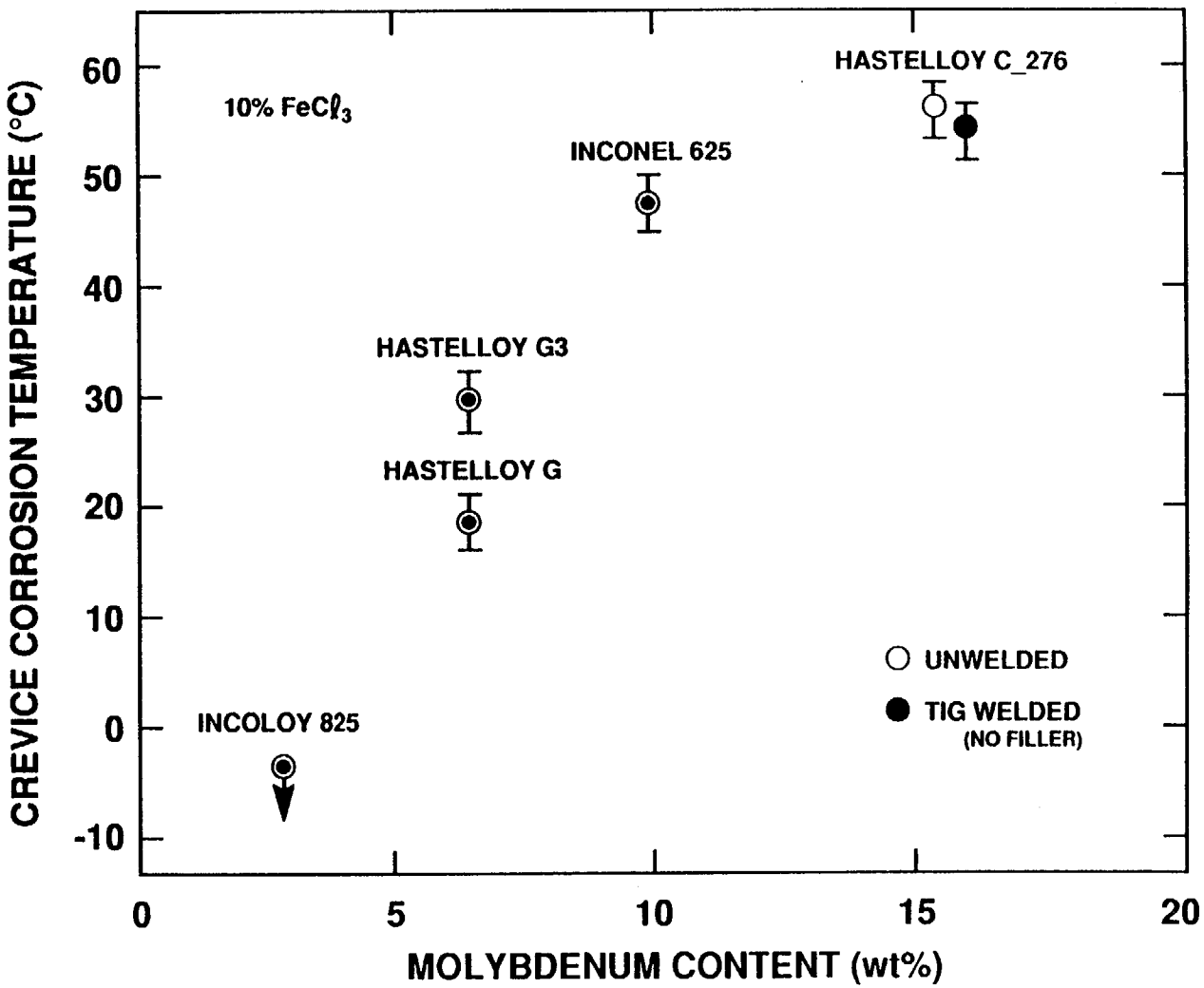


EFFECT OF WELDING ON PITTING (GARNER)



EFFECT OF WELDING ON CREVICE CORROSION

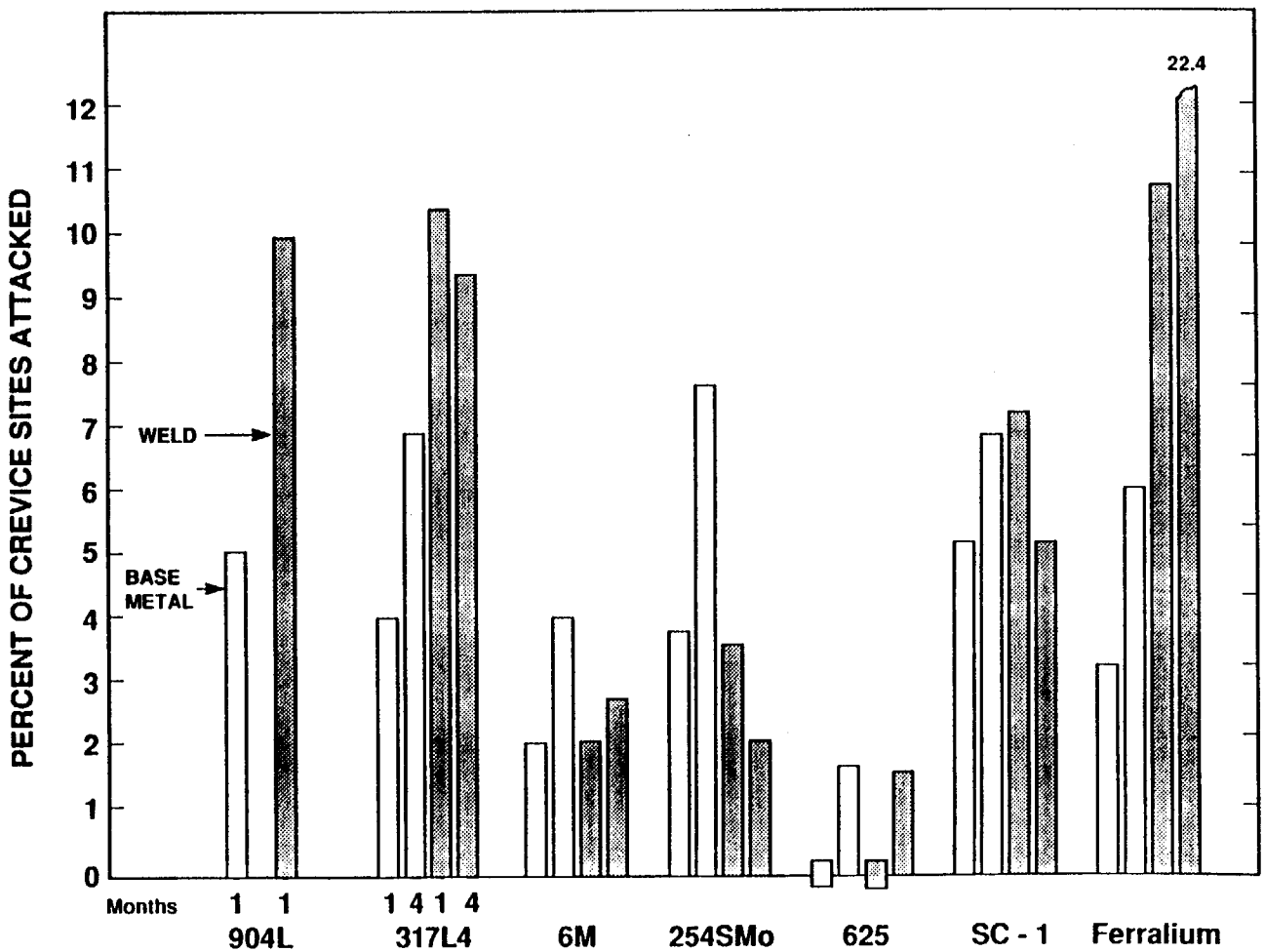
(A.GARNER, 1982)



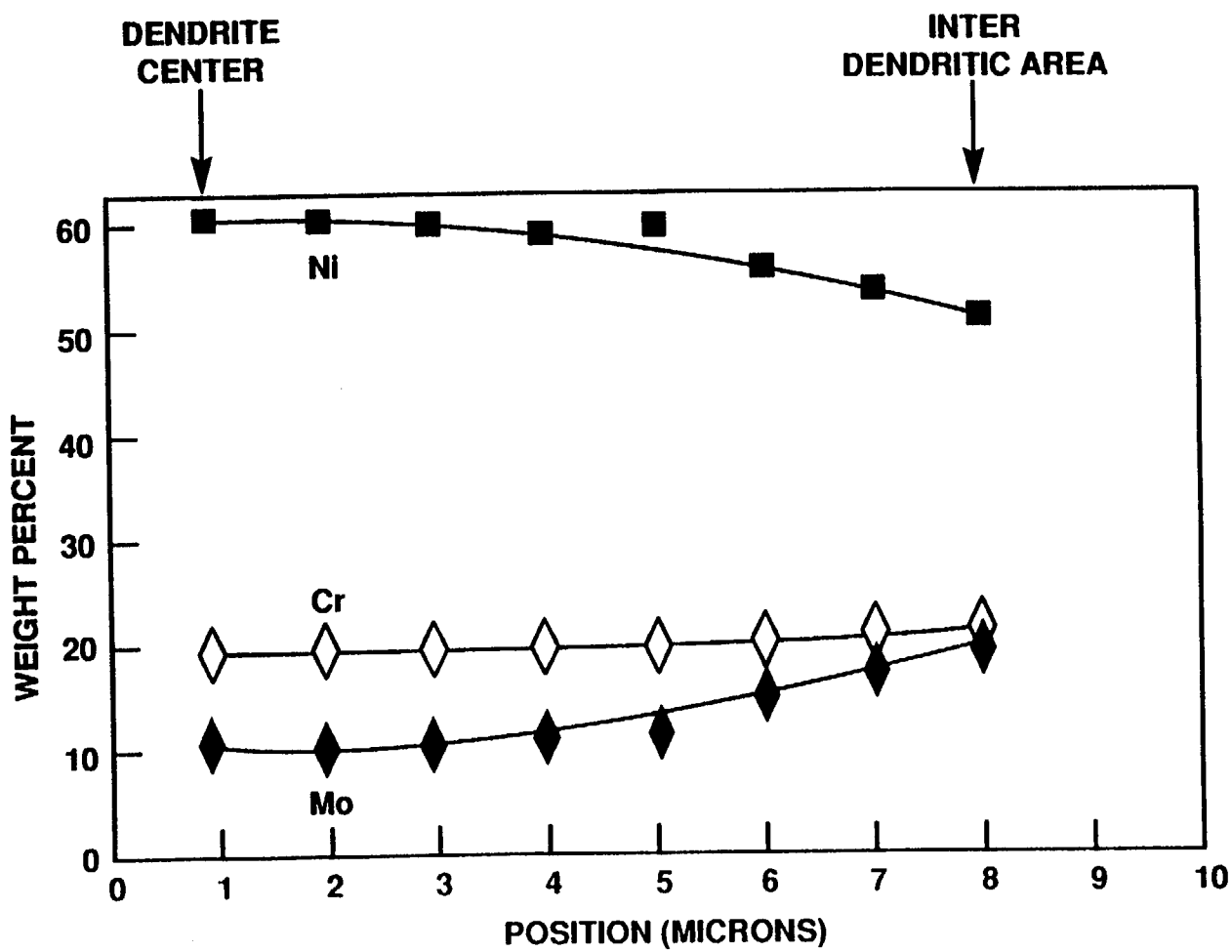
EFFECT OF WELDING ON CREVICE CORROSION IN SIMULATED FGD ENVIRONMENT

1000-50,000 PPM Cl, pH 2, 60-100°C

(REDMERSKI ET AL., 1983)

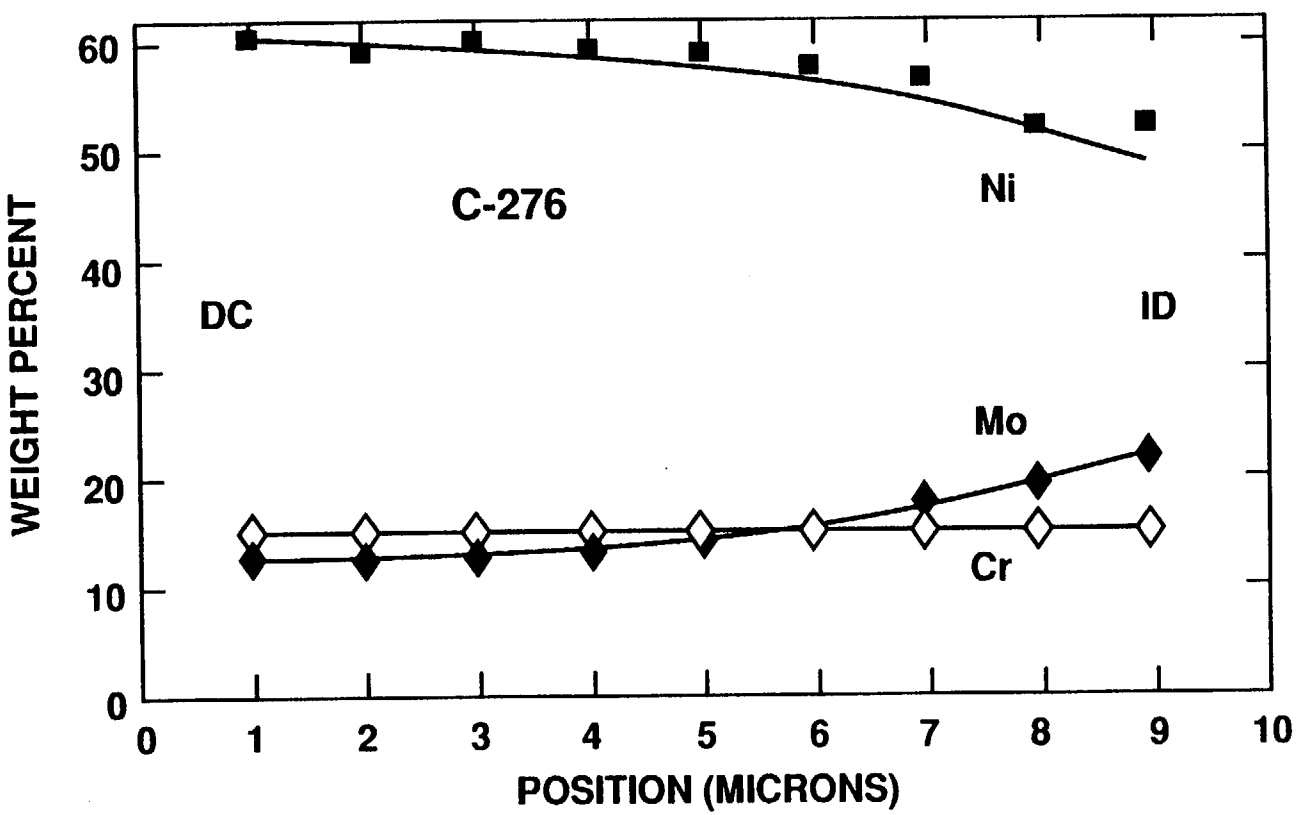


SEGREGATION OF ALLOYING ELEMENTS IN WELD ALLOY C-22
(CIESLAK, et al.)



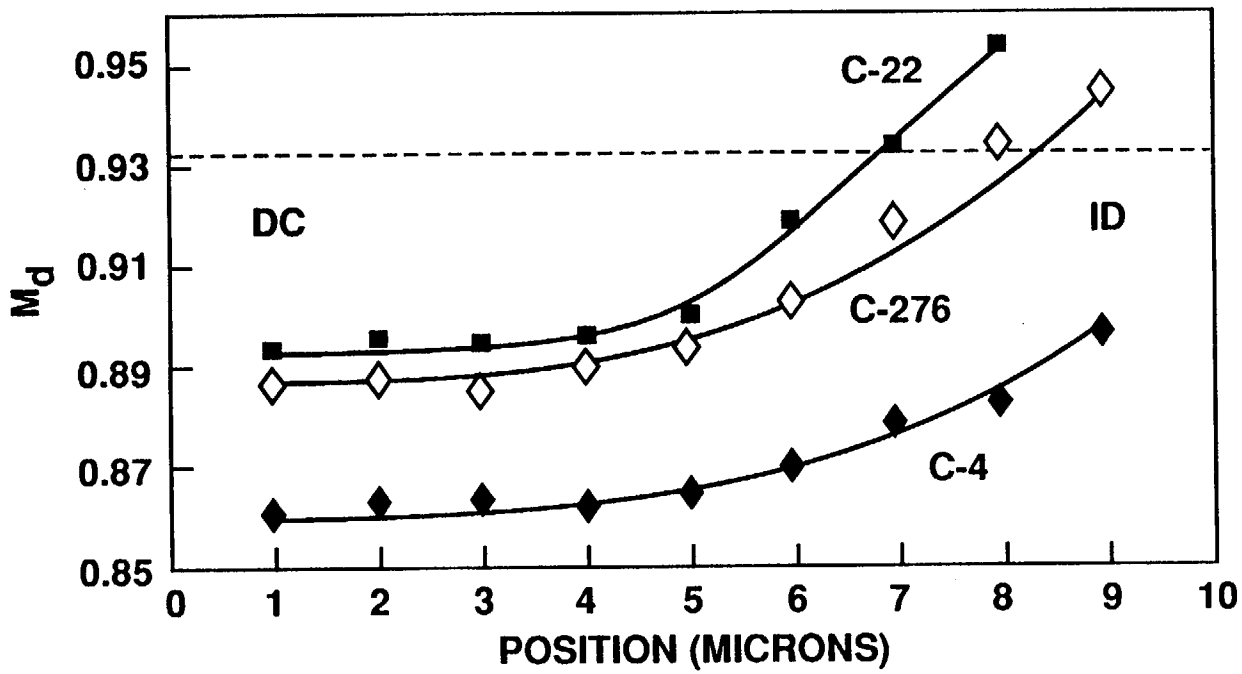
SEGREGATION OF ALLOYING ELEMENTS IN WELD ALLOY C-276

(CIESLAK ET AL.)

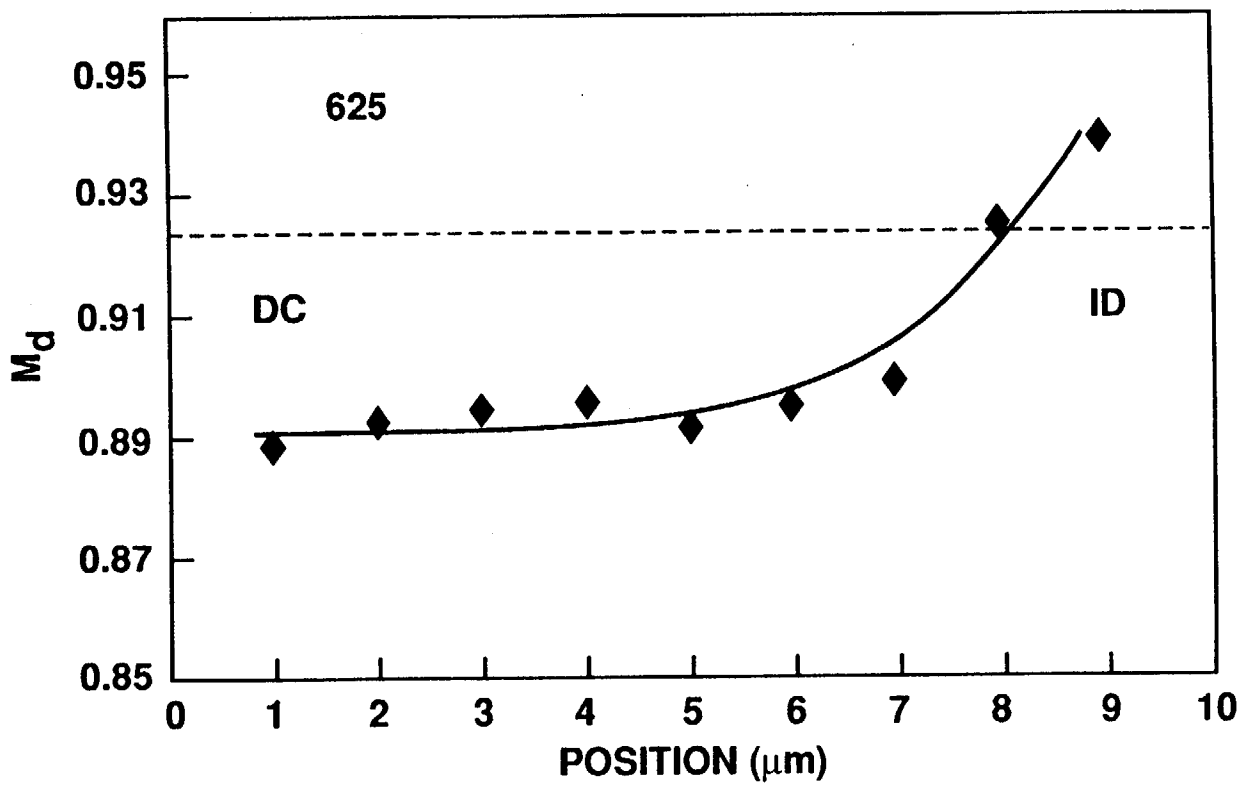


EFFECT OF SEGREGATION ON PHASE STABILITY

(CIESLAK ET AL.,1986)

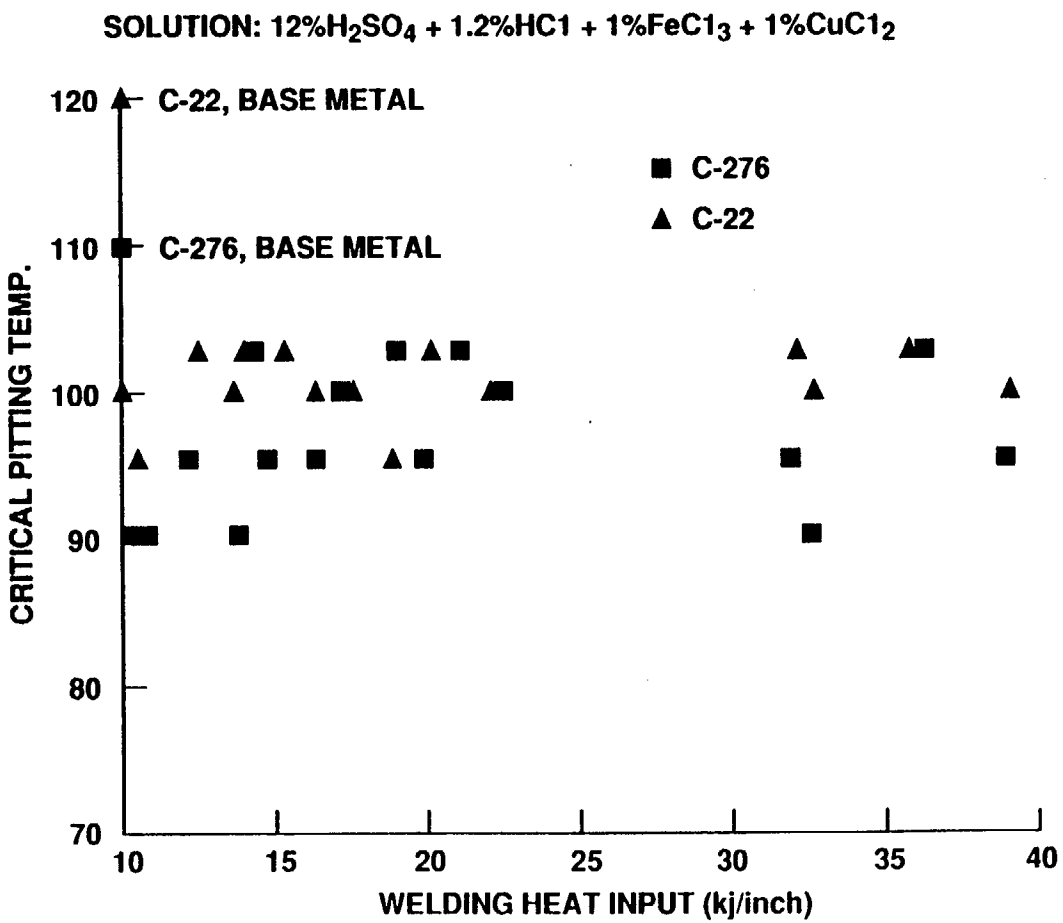


EFFECT OF SEGREGATION ON PHASE STABILITY
(CIESLAK ET AL.,1986)



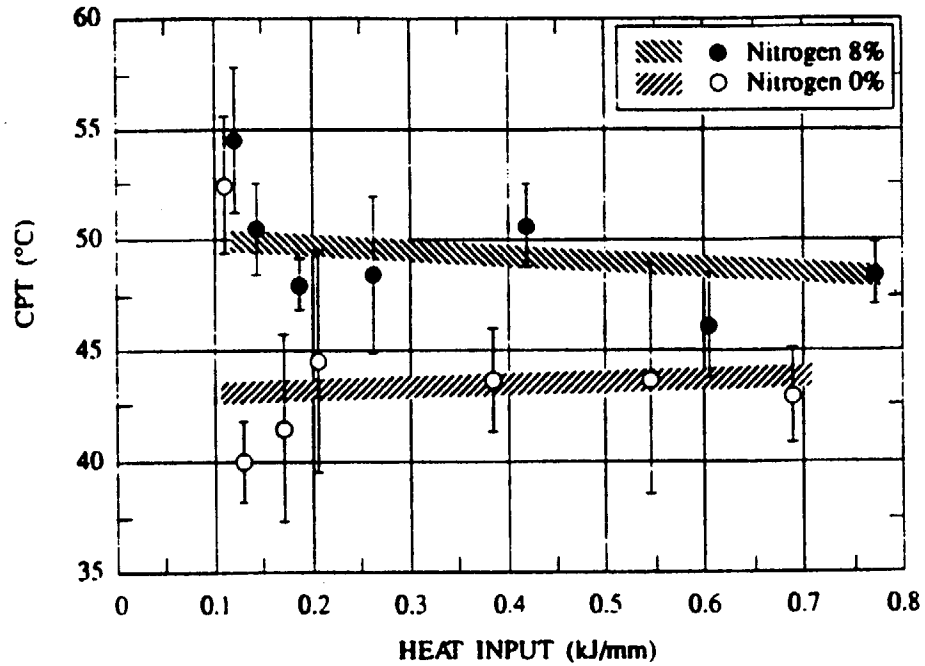
EFFECT OF HEAT INPUT ON PITTING

MULTI-PASS WELDS, GTAW, GMAW
(FLASCHE, 1989)



EFFECT OF HEAT INPUT ON PITTING OF 20Cr-22Ni-6Mo-N STEELS

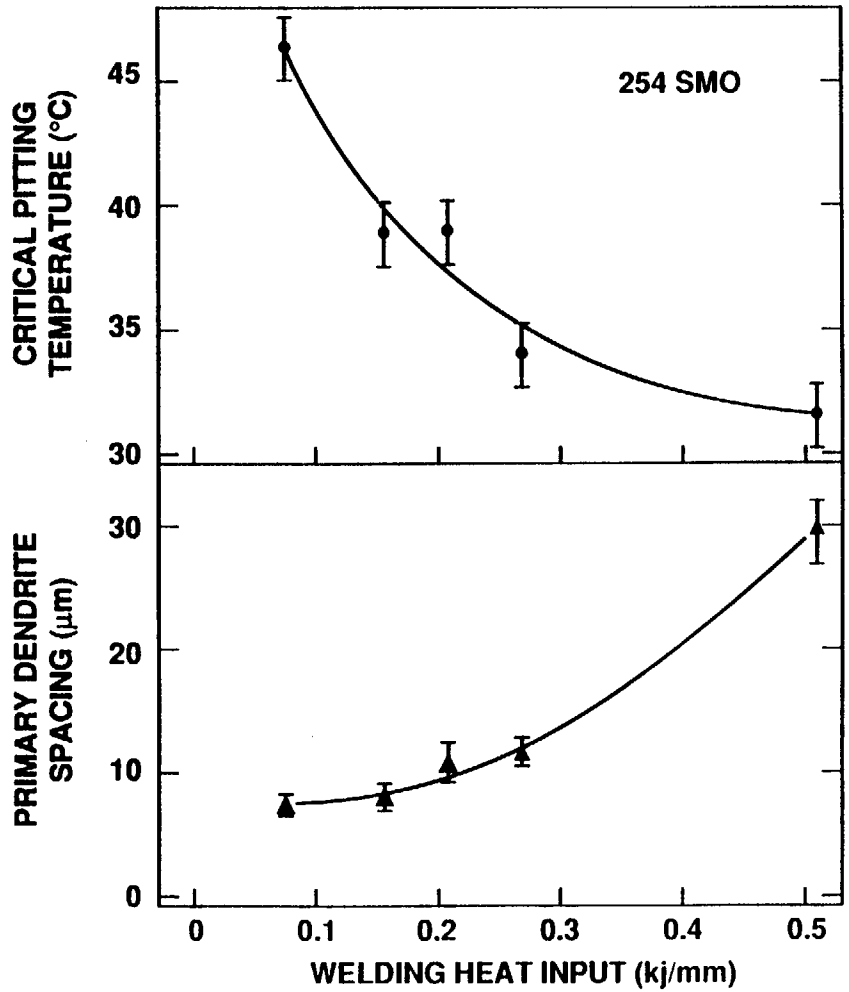
AUTOGENOUS BEAD-ON-PLATE GTAW (LEINONEN ET AL., 1991)



EFFECT OF HEAT INPUT ON PITTING

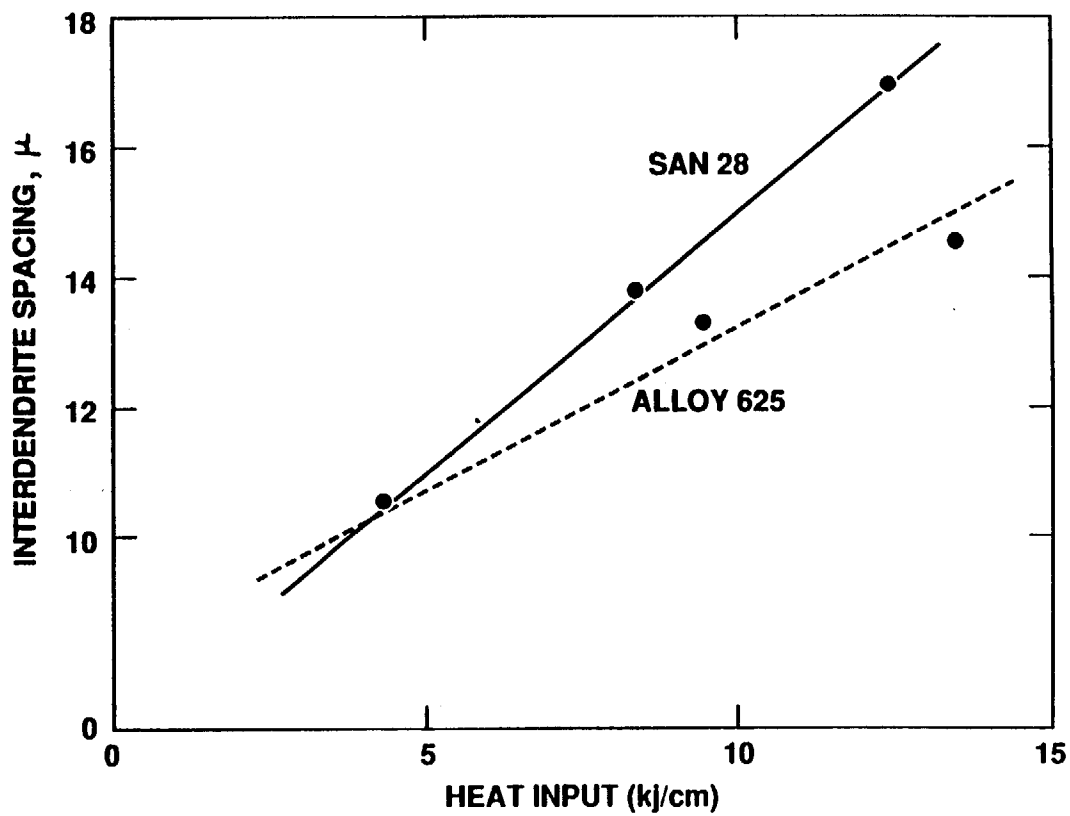
AUTOGENOUS, BEAD-ON-PLATE GTAW

(GARNER, 1982)



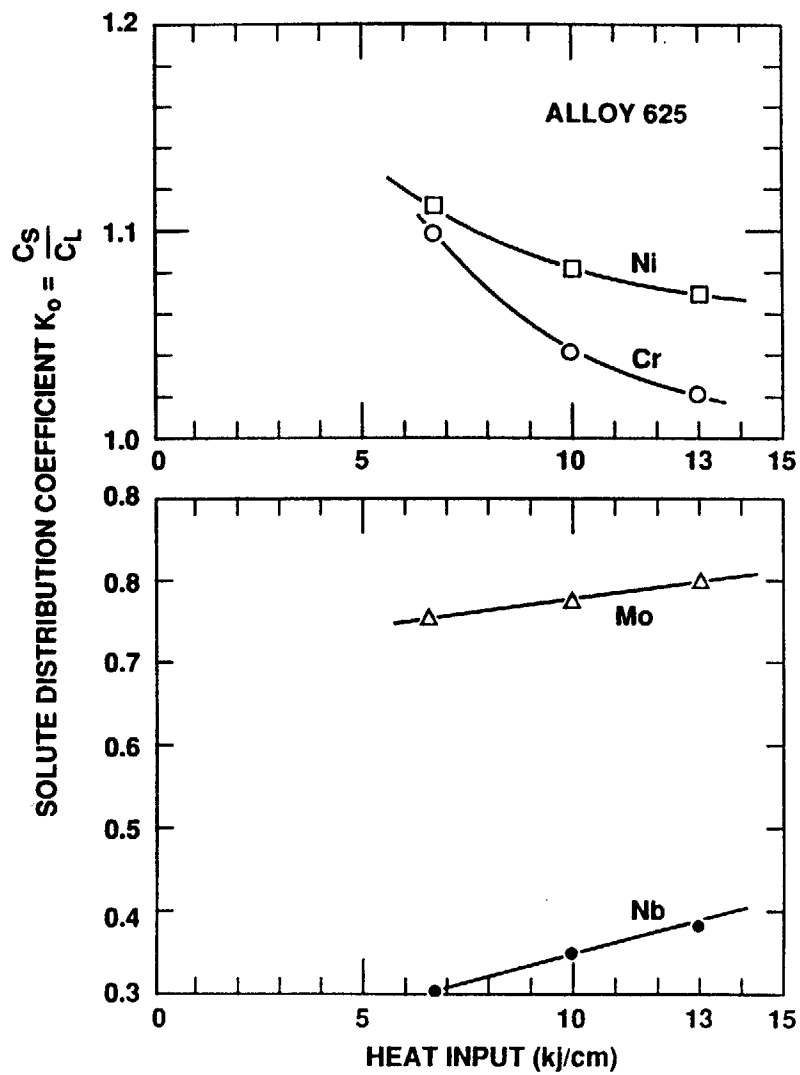
EFFECT OF HEAT INPUT ON INTERDENDRITIC SPACING

MULTI-PASS, SMAW
(RUDOLPH, 1987)



EFFECT OF HEAT INPUT ON SOLUTE DISTRIBUTION IN WELDS

(RUDOLPH, 1987)



SUMMARY OF WELD CORROSION ISSUES PERTINENT TO Ni-Fe-Cr-Mo ALLOYS

- RESISTANCE OF ALLOYS TO LOCALIZED CORROSION IS LIMITED BY THAT OF THE WELD. IN LOWER ALLOYS, THIS CAN BE IMPROVED BY OVERALLOYED FILLER METALS.
- SELECTION OF "OVERALLOYED" FILLER METAL DEPENDS ON THE ENVIRONMENT. EXAMPLE: IN CHLORINE DIOXIDE WASHER ENVIRONMENT, C-22 AND 625 FILLER METALS CORRODED PREFERENTIALLY.
- CORROSION IN UNMIXED ZONE OF WELD LIMITS THE RESISTANCE OF OVERALLOYED FILLER METAL WELDS.
- THE EFFECT OF WELDING HEAT-INPUT IS NOT CLEAR, BUT PROBABLY MARGINAL. FURTHER SYSTEMATIC STUDY UNDER REALISTIC WELDING CONDITIONS NECESSARY.
- VERY LITTLE PUBLISHED LITERATURE EXISTS ON CORROSION BEHAVIOR OF WELDS MADE BY OTEHR TECHNIQUES (Eg. FRICTION/INERTIA, EB, PLASMA ARC).
- DEVELOPMENT OF A MORE RELIABLE AND DISCRIMINATORY CORROSION TEST FOR LOCALIZED CORROSION IS NECESSARY. THE CONCEPT OF REPASSIVATION POTENTIAL AS A LONG-TERM PREDICTIVE TOOL IS BEING PURSUED.