(2)

FY89 End of Fiscal Year Letter
(01 Oct 1988 - 30 Sep 1989)

ONR CONTRACT INFORMATION

Contract Title: "Stainless Steel passivity"

Performing Organization: SUNY

Principal Investigator: C. R. Clayton

Contract Number: 89-J-1068

R & T Project Number: 4315183

ONR Scientific Officer: A. J. Sedriks

A. Description of Scientific Research Goals

Additions of N to Mo bearing and (essentially) Mo free stainless steels result in much higher improvements in general corrosion resistance and pitting resistance. The most dramatic improvements are observed in the Mo bearing steels. This enquiry is attempting to model the roles of N and Mo in passivity.

XPS has been utilized along with electrochemical analysis and a new surface doping treatment devised for this work in order to faciliate this study.

B. Significant Results in the last year

The role of N and Mo appears to be associated in part with formation of mixed surface nitride containing Ni and Cr.

The role of Ni is to be further evaluated, but it appears that a more stable nitride can be found with Cr or Mo in the presence of Ni due to the formation of powerful intermetallic bonding between the hypoelectronic d-metals Cr and Mo and the hyperelectronic d-metal Ni. According to Brewer-Engel criteria the most powerful interaction should be between Ni and Mo (2nd row) compared to Ni and Cr (1st row). This is the first time that a role in the passivation of stainless steel has implicated an active role for Ni which is always absent from passive films but which segregates in the alloy phase. Thus a duplex kinetic barrier composed of an oxide film (previously shown by us to be modified significantly by N) and an underlying mixed nitride phase with strong intermetallic bonding.

New evidence has also been found of the role of anodically segregated N on controlling surface topography during anodic dissolution. This role is highly temperature dependent.

These data have been elucidated from comparative studies of N bearing steels (304, 317, 904L and AL6x) with pure elements (Fe, Cr, Ni and Mo) and the low N analogue of the above steels, following surface nitriding by cathodic deposition of N.

C. Plans for next years research

The implication of Ni and Mo interaction in a nitride phase will be further evaluated utilizing XPS and electron diffraction. Surface doping of N (electrochemically) on to the following alloys will be made to determine the nature of the intermetallic component of the resulting mixed nitrides:- 1) Fe 19Cr 2) Fe 19Cr9Ni 3) Fe 19Cr9Ni-25%Mo. Both the absence of Ni in case 1 and presence of Mo in case 2 should modify the spectra in such a way as to reveal the influence of Mo and Ni.

Further work will continue with higher temperature pitting studies of N bearing stainless steels. This will include the influence of anodically generated suface topography on pitting.

D. List of Publications/Reports/Presentations

1. Papers Published in Refereed Journals

None (papers submitted).

2. Non-Refereed Publications and Published Technical Reports

1) Applications of Directed Energy Beams in Fundamental and Applied Studies of Aqueous Corrosion of Metals. C.R. Clayton in Environmental Degredation of Ion and Laser Beam Treated Surfaces Eds: G. Was and K. Giabowski. TMS Warrendale Penna. 1989, pp 33-59.

2) Evidence of Anodic Segregation of N in high N Stainless Steels and Its Influence on Passivity. C.R. CLayton and K.G. Martin in High Nitrogen Steels Eds: J. Foct and A. Hendry. Metals Institute London, 1989, p. 256.

3. Presentations

a. Invited (1) Applications of Directed Energy Beams in Fundamental and Applied Studies of Aqueous Corrosion of Metals. Fall meeting TMS Chicago, Illinois Sept. 26-29, 1988.

(2) An XPS and Electrochemical Study of the Influence of Molybdenum and Nitrogen on the Passivity of Austenitic Stainless Steel. 6th Int. Symposium on Passivity, Sapporo, Japan Sept. 24-28, 1989.

(3) Effects of Temperature on the Corrosion Resistance of N Bearing Al6x Stainless Steel. K.G. Martin, Y.C. Lu and C.R. Clayton. Fall Meeting Electrochemical Society Chicago Ill. Oct. 1988.

b. Contributed (4) The Effect of N on the Pitting Corrosion of Stainless Steels. First Canadian Materials Science Conference Kingston June 21-23, 1989.

4. Books (and sections thereof)

An Electrochemical Study of the Formation and the Influence of Surface Nitrides on the Anodic Kinetics of Transition Elements and Stainless Steels at R.T. and 40°C. R,D. Willenbruch MS Thesis SUNY Stony Brook, May 1989.

Enclosure (2)

E. LIST OF HONORS/AWARDS

Name of Person Receiving Award	Recipient's Institution	Name, Sponsor and Purpose of Award
—	—	—

Enclosure (3)

F. Participants and Status

(1) Post Doctoral Fellow Yucheng Lu
Is now managing the corrosion laboratory at McMasters University, Hamilton, Ontario, Canada.

(2) R.D. Willenbruch
Graduated with M.S. Now working with Eaton Corporation, Great Neck, New York. (Airborne Instruments Laboratory). Responsible for environmental studies of microelectronic devices.

(3) Gary Halada Studying for Ph.D.

(4) Dongill Kim, new student studying for Ph.D.
(started Sept 1, 1989 with my group).

(5) C.R.Clayton Principal Investigator promoted to Full Professor Sept 1,1989.

G. Other Sponsored Research During FY 89

(1) NSF Sponsored Research Project: Evaluation of the Bipolar Fixed Charge Mechanism of Passivity of Stainless Steel 2/1/86-7/31/89 $220,000.

Now Terminated

(2) Sandia Lab Sponsored Research Project:

Corrosion Research: Amorphous Alloys
22089 - 12/19/89

H. SUMMARY OF FY89
PUBLICATIONS/PATENTS/PRESENTATIONS/HONORS/PARTICIPANTS
(Number Only)

Papers Submitted to Refereed Journals (and not yet published):	1
Papers Published in Refereed Journals:	0
Books (and sections thereof) Submitted for Publication:	1 THESIS.
Books (and sections thereof) Published:	0
Patents Filed:	0
Patents Granted:	0
Invited Presentations at Topical and Scientific/Technical Society Conferences:	4
Contributed Presentations at Topical and Scientific/Technical Society Conferences:	0
Honors/Awards/Prizes:	0
Non-Refereed Publications and Published Technical Reports:	2
Number of Graduate Students:	2
Number of Post Docs:	1