NATIONAL BUREAU OF STANDARDS REPORT

9439

CORROSION RESEARCH

Progress Report
August 9, 1966 - October 9, 1966
OSW No. 14-01-0001-1091

By

H. C. Burnett
Project Coordinator
Metallurgy Division

To

Office of Saline Waters
Department of Interior

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards is a principal focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. Its responsibilities include development and maintenance of the national standards of measurement, and the provisions of means for making measurements consistent with those standards; determination of physical constants and properties of materials; development of methods for testing materials, mechanisms, and structures, and making such tests as may be necessary, particularly for government agencies; cooperation in the establishment of standard practices for incorporation in codes and specifications; advisory service to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; assistance to industry, business, and consumers in the development and acceptance of commercial standards and simplified trade practice recommendations; administration of programs in cooperation with United States business groups and standards organizations for the development of international standards of practice; and maintenance of a clearinghouse for the collection and dissemination of scientific, technical, and engineering information. The scope of the Bureau's activities is suggested in the following listing of its three Institutes and their organizational units.

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Institute for Materials Research. Analytical Chemistry. Polymers. Metallurgy. Inorganic Materials. Reactor Radiations. Cryogenics.* Materials Evaluation Laboratory. Office of Standard Reference Materials.

Institute for Applied Technology. Building Research. Information Technology. Performance Test Development. Electronic Instrumentation. Textile and Apparel Technology Center. Technical Analysis. Office of Weights and Measures. Office of Engineering Standards. Office of Invention and Innovation. Office of Technical Resources. Clearinghouse for Federal Scientific and Technical Information.**

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*Located at Boulder, Colorado, 80301.
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The Institute for Materials Research of the National Bureau of Standards initiated a fundamental study of corrosion phenomena. The program is being conducted by the Metallurgy Division and consists of five tasks for which the titles, objectives, progress and principal investigators are as follows:

Task 1 Polarization Studies and Cathodic Protection
W. J. Schwerdtfeger

Objective: To measure by polarization techniques the instantaneous rates of corrosion (computed weight losses) of a series of selected alloys exposed in the laboratory to synthetic sea water. To compare computed weight losses with actual weight losses. To note the effects of such variables as corrodent temperature, aeration and pH. To look for a possible relationship between computed weight loss and pit depth based on relative apparent areas corroded or based on type of corrosion control (cathodic or anodic).

Progress: Several ferrous and nonferrous alloys of interest to desalination facilities were selected for study and initial steps taken to determine sources of supply. Current plans are to machine the alloy samples to a given size and then expose them to synthetic sea water at room temperature. Polarization studies will be conducted to determine the corrosion rate.

Task 2 Initial Stages of Corrosion Attack
Dr. A. W. Ruff, Mr. D. B. Ballard

Objective: The initial stages of corrosion attack will be studied using electron microscopy and diffraction techniques. Copper - nickel and aluminum-brass alloys will be studied under conditions approximating use in desalination equipment. Thin-film transmission methods and replica studies will be conducted to determine the relation between sample microstructure and behavior in corrosive media. Lifetime predictions may follow by extrapolation of short time tests.

Progress: The equipment needs have been studied and some decisions reached. A stainless steel autoclave will be ordered to permit sample exposure to saline solutions at temperatures up to 350°F. The solutions can be agitated at various rates during exposure, and the pH and oxygen content measured. An optical microscope is on order for preliminary surface study. The type of sample to be studied is under consideration. Several field trips to other relevant research facilities are being planned for the late fall. Due to relocation of our entire laboratory facility, no experimental work is likely before Nov. 15, at which time the electron microscopes should be back in operation and delivery of new equipment should commence.

Task 3 Spectrometric - Ellipsometry of Films Formed on Iron in Aqueous Solution

Dr. J. Kruger, Miss C. L. Foley

Objective: It is proposed to study the electronic properties of the passive films formed on iron by determining their optical constants in the visible region of the spectrum, to determine how these properties altered by the introduction of chloride ions and other species into solution that cause passive film breakdown; and to determine how these properties are changed by a change in the atomic arrangement in the metal substrate.

Progress: Apparatus for forming films to be studied by spectrometric ellipsometry has been designed. Initial experiments will involve obtaining the spectra of both films formed in dry oxygen and in neutral buffered aqueous solutions by anodic polarization. This will serve as a base line for determining the influence of chloride ions on the spectra obtained.

Task 4 Structure and Growth Kinetics of Oxide Films on Iron

Dr. A. J. Melmed

Objective: Significant progress in understanding surface phenomena can only be expected as the result of several types of investigation on a given problem. Often this is made difficult or uncertain by the fact that each investigation may be done under different experimental conditions. We propose to avoid these uncertainties by combining three surface-study tools into one research instrument (ELF), specifically an ultra-high vacuum instrument which will permit the simultaneous observation of a metal surface by ellipsometry and low-energy-electron diffraction. The instrument will also have a field-electron-emission microscope built into the specimen region. It is proposed to study simultaneously, during the oxidation of metals by gaseous oxygen, the atomic structure, by the technique of low-energy electron diffraction, and growth kinetics, by the optical technique of ellipsometry.

Progress: The ELF instrument and associated vacuum and electrical apparatus have been assembled and tested. The three component techniques in the ELF (Ellipsometry, E, Low energy electron diffraction, L, and Field electron emission microscopy, F) have been successfully applied in a preliminary experiment concerning the interaction of oxygen and tungsten. In this experiment thus far, the value of ELF in establishing clean surface conditions, has been demonstrated, and a qualitative comparison was made of the relative sensitivity of E, L, and F for room temperature oxygen adsorption on the (001) plane of tungsten.

Task 5 Relation of Corrosion to the Electronic Structure of Alloys
Dr. L. H. Bennett

Objective: It has been observed that the corrosion rate in seawater of copper-nickel alloys is reduced by the addition of small quantities of iron or manganese. An understanding of this effect, which is as yet unexplained, could lead to the development of more corrosion resistant materials. It is suggested that the effect of iron or manganese on copper-nickel alloys may be to produce a so-called "local moment". It is proposed to investigate this possibility experimentally.

Progress: The first step in attempting to relate local moment formation of Fe in Cu-Ni alloys and corrosion rate will be setting up and calibrating a Mossbauer spectrometer.

It has been decided to use a system similar to that of Ruegg, Spijkerman and DeVoe (Rev. Sci. Instr. 36, 356, 1965) with several modifications designed to improve linearity and to increase driving power to that which will be required when driving a sample with a long rod reaching into a helium magnet dewar.

Most of the basic instrumentation required, e.g. a multichannel analyzer, proportional counter, high voltage power supply and preamplifier, has been purchased. The velocity transducer and its driver electronics have been constructued and preliminary spectra at room temperature for use in calibration have been obtained.

The analysis of the calibration spectra and of future spectra will require the use of computer techniques. Since the readout from the multi-channel analyzer is in the form of punched paper tape from a teletype, a computer program is being developed for its efficient conversion into punched cards using the Bureau's CDC 3100 computer, which is equipped with a paper tape reader. These cards will be used as the data input for use on a large scale computer such as the IBM 7604 or Univac 1107, for which a computer program is also being developed.


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