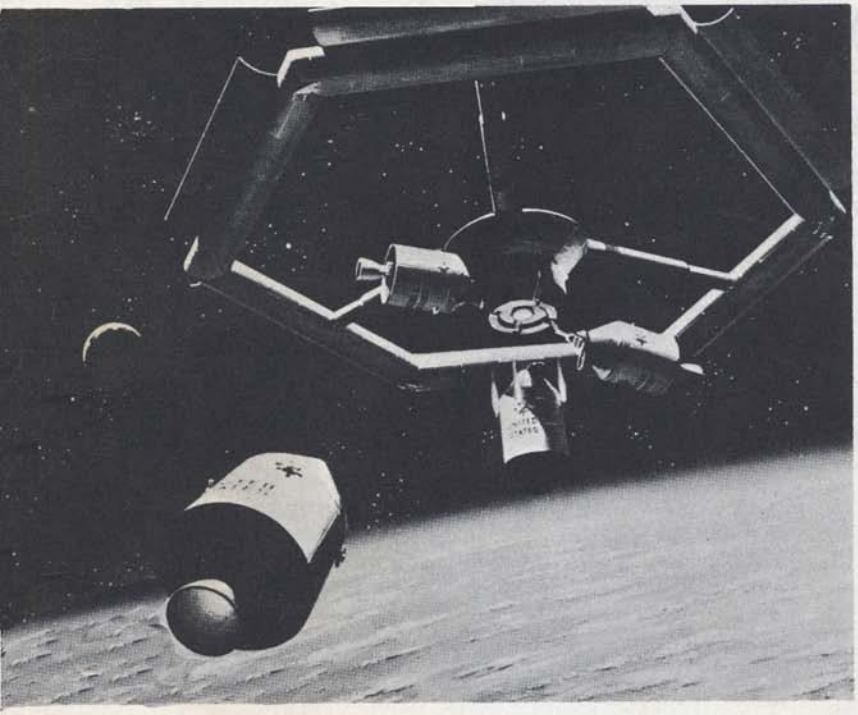
Symposium on Adhesion or Cold Welding of Materials in Space Environments



AMERICAN SOCIETY FOR TESTING AND MATERIALS

AMERICAN SOCIETY OF LUBRICATION ENGINEERS

1-2 May 1967

King Edward-Sheraton Hotel, Toronto, Ontario, Canada

ADHESION, OR COLD WELDING,

OF

MATERIALS IN SPACE ENVIRONMENTS

A two-day symposium to examine the fundamental mechanisms and engineering aspects of solid state adhesion phenomena of materials in ultra-high vacuum environments is being presented by the American Society for Testing and Materials and the American Society of Lubrication Engineers, 1 and 2 May, 1967 in Toronto, Canada. The purpose of this symposium is to bring together a number of brief general reviews of the scientific disciplines directly associated with the processes of adhesion, or cold welding, the observed data from direct adhesion experimentation, and those observations from the applied fields, i.e. friction, such that all researchers are cognizant of the recent advances in the state of the science and the interdisciplinary nature of the phenomena. The large cross-section of researchers presenting papers and the available time for discussion between papers is expected to promote a wealth of information exchange beyond the formal papers. The program was designed to examine the known properties of solid surfaces under space conditions with respect to chemistry, structure, and adsorptive properties; and then examine the possible effects of these parameters on adhesion phenomena in metallic and ceramic systems.

The first session is entitled the "Nature of Solid Surfaces" and will involve discussions of the surface chemistry of adhesion by A. W. Adamson, the preparation and characterization of clean surfaces by R. W. Roberts, studies of gas surface processes using low energy electron diffraction techniques by L. May, adhesion as observed by field ion microscopy by E. W. Muller et al, and elucidation of surfaces through sputtering by G. K. Wehner. The papers of this session were provided to create a broad insight into the nature and expected behavior of ultra-clean metal and ceramic surfaces, since adhesion phenomena in these systems is singularly dependent on the nature of the atomic species, either substrate atoms or sorbed gas atoms, present at the interface at the time of bond formation.

The correlation of the behavior of ideal material systems discussed in the first session to those which are actually experienced in engineering practice is brought to task in the second session. The cold welding of materials which are brought into contact in very high vacuum environments, is generally recognized; however, in order to ascertain the effect of the ambient conditions, temperature, material composition on the extent of the adhesion process, researchers must be cognizant of the problems in accurately measuring the attractive forces and in properly simulating those properties of outer space. R. Hammel and J. Rittenhouse propose to examine the problem of engineering testing and space simulation, respectively, while W. Gilbreath, M. Hordon, and L. Kellogg et al discuss the results of certain variables on the adhesion process in engineering studies. A considerable amount of experimental data will be presented during this session.

Session three is directed toward the middle ground between the first two sessions in attempting to resolve the basic mechanisms by which two solid materials form a stable interface, and those mechanisms which inhibit this process. Adhesion in metallic systems apparently occurs between any two metals with an interfacial strength equal to the bulk strength of the weaker material. The process is independent of the applied load, but can be interrupted by as little as a monolayer of sorbed impurity as indicated by recent investigations by D. V. Keller. Oxide systems demonstrate sizable long range attractive forces prior to bulk contact and substantial interfacial strength when contact is finally complete. These works will be discussed by J. A. Ryan. A theoretical discussion of the surface charging of oxide systems is also incorporated by J. J. Grossman. Adhesion of copper by H. Conrad et al and of iron by T. E. Johnson are discussed.

The relationship of adhesion to friction phenomena has long been recognized and is considered in session four. D. H. Buckley will present a discussion of the influence of crystal orientation and structure on the friction and adhesion behavior of many metal systems at pressures below 10^{-10} torr. The conclusion of Buckley's work points most strongly to the intimacy of the adhesion-friction relationship. The effects of natural (gases) lubricants of MoS_2 and WS_2 in ultra-high vacuum friction studies is discussed by A. Haltner. The investigation, a new technique for the determination of the coefficient of friction, will be presented by S. Podlaseck et al and M. Antler will discuss the wear of electrodeposited gold.

PROGRAM

MONDAY, 1 MAY

8:30 Registry for Extended Abstracts and Publications

Opening Statement: Chairman, D. V. Keller, Jr.

SESSION 1: NATURE OF SOLID SURFACES
Chairman: J. A. Ryan, Douglas Aircraft Co., Santa Monica, Calif.
Co-Chairman: R. P. Steijn, E. I. duPont de Nemours, Wilmington, Del.

1-1* (9:00) Some Aspects of the Surface Chemistry of Adhesion
A. W. Adamson, University of Southern California

1-2 (9:35) Clean Surfaces, Their Preparation and Characterization
R. W. Roberts, General Electric Research Center

1-3 (10:00) Gas-Surface Processes and LEED
John May, Cornell University

(10:35) Coffee Break

1-4 (10:55) Atomic Surface Structure of the Common Transition Metals and the Effect of Adhesion as Seen by Field Ion Microscopy
E. W. Müller and O. Nishikawa, Pennsylvania State University

1-5 (11:00) The Contribution of Sputtering to Our Knowledte of Plasma-Surface Interactions
G. K. Wehner, Litton Systems, Inc.

SESSION 2: ENGINEERING ASPECTS OF ADHESION
Chairman: R. L. Hammel, TRW Systems, Redondo Beach, Calif.
Co-Chairman: H. E. Ries, American Oil Co., Whiting, Ind.

2-1 (2:00) The Problems of Engineering Testing for Coldwelding
R. L. Hammel, TRW Systems

2-2 (2:20) Space Simulation Testing of the Adhesion of Materials
John B. Rittenhouse, Lockheed Missiles and Space Co.

2-3 (2:45) Adhesion of Metals in High Vacuum
M. J. Hordon, National Research Corporation

(3:05) Coffee Break

2-4 (3:25) Definition and Evaluation of Parameters which Influence the Adhesion of Metals
W. P. Gilbreath, NASA-Ames Research Center

2-5 (3:50) Flight Reactor Materials Development, Self-Weld Studies
L. G. Kellogg, Atomics International

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* These numbers are repeated in the individual abstracts.

TUESDAY, 2 MAY

SESSION 3: ADHESION: MECHANISM AND THEORY
Chairman: W. P. Gilbreath, NASA-Ames Research Center, Moffett Field, Calif.
Co-Chairman: D. C. Flom, General Electric Co., Valley Forge, Pa.

3-1 The Analysis of Metallic Adhesion Data
(9:00) D. V. Keller, Syracuse University

3-2 Cold Welding in Copper in an Ultra-High Vacuum
(9:40) H. Conrad and L. A. Rice, The Franklin Institute Research Laboratories

3-3 Solid-Phase Joining of 99.8 Per Cent Iron
(10:10) T. E. Johnson, Jr., United States Steel Corporation

(10:30) Coffee Break

3-4 Adhesional Behavior of Air and Ultra-High Vacuum Formed Silicate Surfaces
(11:00) J. A. Ryan and M. B. Baker, Douglas Aircraft Co., Inc.

3-5 Mineral Cleavage and Cohesive Strength of Single Crystals
(11:25) George W. DeVore, Florida State University

3-6 Production of Surface Electrostatic Charging on Dielectrics Cleaved in Vacuum: Theoretical
(11:55) Jack J. Grossman, Douglas Aircraft Company

SESSION 4: ADHESION AS RELATED TO FRICTION
Chairman: S. Podlaseck, Martin Marietta Corp., Baltimore, Md.
Co-Chairman: Vern Hopkins, Midwest Research Institute, Kansas City, Mo.

4-1 The Influence of Crystal Structure, Orientation and Solubility on the Adhesion and Sliding Friction of Various Metal Single Crystals in Vacuum (10^{-11} Torr).
(2:00) D. H. Buckley, NASA - Lewis Research Center

4-2 Friction of Tungsten Disulfide Sliding in an Ultra-High Vacuum System
(2:20) A. J. Haltner, General Electric Co.

(3:05) Coffee Break

4-3 The Wear of Electrodeposited Gold
(3:25) M. Antler, Burndy Corp.

4-4 A Statistical Method for the Study of Sliding Friction and Wear in Vacuum
(4:00) S. Podlaseck and H. Shen, Martin Marietta Corp.

(4:30) Closing Statement: D. V. Keller, Jr.