

# Fourth Pacific Area Meeting Papers

*Symposium on*

## MATERIALS FOR AIRCRAFT, MISSILES, AND SPACE VEHICLES



Published by the  
AMERICAN SOCIETY FOR TESTING AND MATERIALS  
1916 Race St., Philadelphia 3, Pa.

*ASTM Special Technical Publication No. 345*

# SYMPOSIUM ON MATERIALS FOR AIRCRAFT, MISSILES, AND SPACE VEHICLES

---

Presented at the  
FOURTH PACIFIC AREA NATIONAL MEETING  
AMERICAN SOCIETY FOR TESTING AND MATERIALS  
Los Angeles, Calif., September 30–October 5, 1962



Reg. U. S. Pat. Off.

---

*ASTM Special Technical Publication No. 345*

---

Price \$7.00; to Members \$4.90

Published by the  
AMERICAN SOCIETY FOR TESTING AND MATERIALS  
1916 Race St., Philadelphia 3, Pa.

© BY AMERICAN SOCIETY FOR TESTING AND MATERIALS 1963  
Library of Congress Catalog Card Number: 63-20730

---

Printed in Baltimore, Md.  
October, 1963

## FOREWORD

---

Emphasis in this Symposium on Materials for Aircraft, Missiles, and Space Vehicles is on increasing knowledge of structural stability and fracture toughness of materials intended for aerospace applications.

The Symposium, sponsored by the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals, was held in three sessions on October 4 and 5, 1962, during the Fourth Pacific Area National Meeting of the Society.

Mr. J. F. Watson, General Dynamics/Astronautics, served both as overall Symposium Chairman and as chairman of the Session on Effects of Combined Environments. Mr. J. F. Boysen, The Boeing Co., was chairman of the Session on Metallic Materials, while Mr. R. B. Clapper, Lockheed Missiles and Space Co., was chairman of the Session on Nonmetallic Materials. Presiding officers of the three sessions were Messrs. A. Hurlich, General Dynamics/Astronautics; L. Spalding, North American Aviation, Inc.; and E. Troeger, Douglas Aircraft Co.

Of the papers presented at the Symposium, one entitled "Obtaining Materials Behavior Information on New Ablative Heat Shield Materials" by L. S. Lazar and T. K. Pugmire has not been included in this volume. Another paper, "Technique for Making Shallow Cracks in Sheet Metals" by C. S. Yen and S. L. Pendleberry, was published in *Materials Research & Standards*, Vol. 2, No. 11, Nov., 1962, p. 913.

NOTE.—The Society is not responsible, as a body, for the statements  
and opinions advanced in this publication.

## CONTENTS

---

	PAGE
Introduction—J. F. Watson.....	1
<b>Effects of Combined Environments</b>	
Fatigue Testing of Aluminum in Vacuum—John L. Ham and George S. Reichenbach.....	3
Lubrication of Ball Bearings for Space Applications—F. J. Clauss, S. P. Drake, and W. C. Young.....	14
Discussion.....	39
Effects of the Ascent Environment on Spacecraft Thermal Control Surfaces— W. F. Schmidt, L. A. Haslim, and L. A. McKellar.....	40
Discussion.....	51
Effect of Nuclear Radiation on Tensile Properties of High-Strength Materials at 20 K and 294 K—J. F. Watson, J. L. Christian, and J. W. Allen.....	52
Discussion.....	73
<b>Metallic Materials</b>	
Tuned <i>Q</i> Analysis of Quench and Precipitation Hardening of 4330M and 17-7PH Steels—I. G. Hendrickson.....	74
Method of Test for Hydrogen Embrittlement Due to Electrolytic Cadmium Plat- ing—B. G. Johnson.....	82
Effect of Decarburization on Fracture Toughness of an Ultrahigh-Strength Sheet Steel—J. P. Sheehan and R. D. Manning.....	89
Discussion.....	98
An Analysis of Strain Gage Measurements Under Transient Heating Conditions— Curtis E. Johnson.....	99
<b>Nonmetallic Materials</b>	
Shear Test for Adhesive Bonds—L. R. Lunsford.....	110
Discussion.....	118
Compressive Properties of Pyrolytic Graphite from Room Temperature to 5000 F —L. P. Gobble and W. J. Salmen.....	119
Testing Materials in a Plasma Arc Under Simulated Re-entry Conditions—M. A. Hagan and George Martin.....	129

THIS PUBLICATION is one of many issued by the American Society for Testing and Materials in connection with its work of promoting knowledge of the properties of materials and developing standard specifications and tests for materials. Much of the data result from the voluntary contributions of many of the country's leading technical authorities from industry, scientific agencies, and government.

Over the years the Society has published many technical symposiums, reports, and special books. These may consist of a series of technical papers, reports by the ASTM technical committees, or compilations of data developed in special Society groups with many organizations cooperating. A list of ASTM publications and information on the work of the Society will be furnished on request.

