

HANDBOOK OF PHYSICAL VAPOR DEPOSITION (PVD) PROCESSING

Film Formation, Adhesion, Surface Preparation and Contamination Control

by

Donald M. Mattox

Society of Vacuum Coaters
Albuquerque, New Mexico



NOYES PUBLICATIONS
Westwood, New Jersey, U.S.A.

ClearCorrect Exhibit 1046, Page 1 of 943

Copyright © 1998 by Noyes Publications
No part of this book may be reproduced or utilized
in any form or by any means, electronic or
mechanical, including photocopying, recording or
by any information storage and retrieval system,
without permission in writing from the Publisher.
Library of Congress Catalog Card Number: 97-44664
ISBN: 0-8155-1422-0
Printed in the United States

Published in the United States of America by
Noyes Publications
369 Fairview Avenue, Westwood, New Jersey 07675

10 9 8 7 6 5 4 3 2 1

Library of Congress Cataloging-in-Publication Data

Mattox, D. M.
Handbook of physical vapor deposition (PVD) processing / by
Donald M. Mattox.
p. cm.
Includes bibliographical references and index.
ISBN 0-8155-1422-0
1. Vapor-plating--Handbooks, manuals, etc. I. Title.
TS695.M38 1998
671.7'35--dc21 97-44664
CIP

Dedication

**To my wife
Vivienne**

Without Vivienne's constant support, encouragement, and editorial assistance, this book would not exist. Her wide spectrum of contacts within the vacuum equipment and PVD technology industries has made the accumulation of information in some sections of this book possible.

v

ClearCorrect Exhibit 1046, Page 3 of 943

NOTICE

To the best of our knowledge the information in this publication is accurate; however the Publisher does not assume any responsibility or liability for the accuracy or completeness of, or consequences arising from, such information. This book is intended for informational purposes only. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the Publisher. Final determination of the suitability of any information or product for use contemplated by any user, and the manner of that use, is the sole responsibility of the user. We recommend that anyone intending to rely on any recommendation of materials or procedures mentioned in this publication should satisfy himself as to such suitability, and that he can meet all applicable safety and health standards.

Preface

The motivation for writing this book was that there was no single source of information which covers all aspects of Physical Vapor Deposition (PVD) processing in a comprehensive manner. The properties of thin films deposited by PVD processes depend on a number of factors (see Sec. 1.2.2), and each must be considered when developing a reproducible process and obtaining a high product throughput and yield from the production line.

This book covers all aspects of PVD process technology from characterizing and preparing the substrate material, through the deposition process and film characterization, to post deposition processing. The emphasis of the book is on the aspects of the process flow that are critical to reproducible deposition of films that have the desired properties.

The book covers both neglected subjects, such as film adhesion, substrate surface characterization, and the external processing environment, and widely discussed subjects, such as vacuum technology, film properties and the fundamentals of individual deposition processes. In this book, the author relates these subjects to the practical issues that arise in PVD processing, such as contamination control and substrate property effects on film growth, which are often not discussed or even mentioned in the literature. By bringing these subjects together in one book, the author has made it possible for the reader to better understand the interrelationships between various aspects of the processing and the resulting film properties. The author draws upon his long experience in developing PVD processes, teaching short courses on PVD processing, to not only present the basics but

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.