Sputtering by Particle Bombardment I

Physical Sputtering of Single-Element Solids

Edited by R. Behrisch

With Contributions by
H. H. Andersen H. L. Bay R. Behrisch
M. T. Robinson H. E. Roosendaal P. Sigmund

With 117 Figures

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Dr. *Rainer Behrisch*

Max-Planck-Institut für Plasmaphysik, Euratom Association
D-8046 Garching/München, Fed. Rep. of Germany

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Preface

Sputtering phenomena have become of great importance in physics and technology within the last 25 years. This is demonstrated by the inclusion of sputtering in a large number of national and international conferences dealing with topics such as vacuum physics, surface physics, surface analysis, thin films, electron microscopy, atomic collisions, radiation damage, ion implantation and plasma physics. However, there have been very few conferences dealing with sputtering alone and today's knowledge about this process is widely distributed in the scientific and technical literature.

In the three volumes of this Topics in Applied Physics series, an attempt has been made to collect most of today's information about the experimental and theoretical knowledge on sputtering phenomena as well as to show the applications of this process. This task was not possible in a monograph, but only by the contribution of several experts in this field. Every contribution represents the personal view of each author, but an effort was made to get the articles to fit together in a coherent way. Mostly the symbols are used and cross references between the articles are given.

This first volume deals with the physical basis for sputtering of single element solids. After a general overview, two chapters deal with the theoretical basis for understanding sputtering phenomena in amorphous, polycrystalline and single crystal solids followed by two chapters presenting a collection of the experimental results.

Chapter 2 by P. Sigmund starts with a historical survey about the different models developed for the sputtering process. For knockon sputtering caused by a collision cascade, first-order analytical formulas are derived for the sputtering yield in amorphous materials as well as for the angular and energy distributions of the emitted particles. These are valid for the linear cascade regime, i.e., heavy ions at keV energies. Further, corrections for other regimes are presented.

In Chap. 3, Mark T. Robinson discusses the influence of the crystalline structure of the solid as well as the selvage, i.e., the surface layer, and the surface binding energies on the sputtering process. The ideas of crystal transparency and channeling give a basis for understanding the orientation dependence of the sputtering yields. However, for a comprehensive description of the sputtering process, computer models have to be applied and several examples are given.

In chapter 4, H. H. Andersen and H. L. Bay present an overview of all results reported in the literature about measured sputtering yields and their

dependence on different parameters. This contribution shows that there are very few measurements of sputtering yields for the systems other than metals bombarded by particles other than noble gas ions.

The last chapter by H. E. Roosendaal deals with sputtering yield measurements for single crystals, especially their dependence on orientation. These effects can only be observed at low fluences or, if the annealing of defects in the crystal is larger than amorphization due to the radiation damage within the range of the incident ions.

In each chapter the references are numbered consecutively as they appear in the text. In order to facilitate search for the work of one author, an alphabetical author index has been provided and is added, together with the subject index at the end of the book.

The second volume will deal with the sputtering of multicomponent targets such as alloys and compounds, chemical sputtering and sputtering by electrons and neutrons. Two chapters will deal with the surface structures which are developed for heavy and light ion bombardment.

In the third volume, today's knowledge about the angular, energy, mass and charge-state distribution of sputtered particles will be presented. Finally the large variety of applications for the sputtering process will be outlined.

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Contents

Contributors

Hans Henrik Andersen
Det Fysiske Institut, Aarhus Universitet
DK-8000 Aarhus C, Denmark

Helge L. Bay
Institut für Plasmaphysik, Kernforschungsanlage Jülich,
Euratom Association, D-5170 Jülich, Fed. Rep. of Germany

Rainer Behrisch
Max-Planck-Institut für Plasmaphysik, Euratom Association
D-8046 Garching/München, Fed. Rep. of Germany

Mark T. Robinson
Solid State Division, Oak Ridge National Laboratory
Oak Ridge, TN 37830, USA

Hans E. Roosendaal
Universität Bielefeld, Fakultät für Physik, Universitätsstraße 25
D-4800 Bielefeld 1, Fed. Rep. of Germany

Peter Sigmund
Fysiske Institut, Odense Universitet
DK-5230 Odense M, Denmark