Semiconductors and Semimetals

Edited by J. I. Pankove

(Volume 21 Hydrogenated Amorphous Silicon, Part A Preparation and Structure, 1984, Academic Press)

Hyrdrogenated amorphous silicon (a-Si:H) is a semiconductor with many scientific applications. In this volume, the preparation of a-Si:H by glow discharge, sputtering and chemical vapor disposition (CVD) is discussed along with the characteristics of the silane plasma and the resultant atomic and electronic structure. New preparation methods recently developed are also introduced. The reader can readily understand the preparation and the structure of a-Si:H through discussion based on extensive experimental data in Chapters 2-14.

There are many ways to prepare a-Si:H. They are discussed in detail in Chapters 2-7. The most common method is the glow discharge decomposition of silane. Chapters 2 and 3 discuss the rf and dc methods, respectively. Chapter 4 describes sputtering. Sputtering is a well-developed industrial process capable of fast deposition. Chapter 5 describes the ion beam deposition method. This method is designed to condense the Si vapor into aggregates whose size is on the order of 100-1000 atoms. Chapter 6 describes CVD. The pyrolytic decomposition of silane at 450°C produces an amorphous film that contains a small concentration of (~2 at %) of hydrogen. At ~600°C, a microcrystalline layer is obtained and above ~700°C the material becomes polycrystalline. Chapter 7 introduces HOMOCVD. A-Si:H prepared by this method have a high concentration of hydrogen (up to 40%).

An electric field in the glow-discharge decomposition is used to produce a plasma containing ions, radicals and other species, which condense on a heated substrate to form an amorphous solid. Chapter 8 reviews the interaction of ions and other reactive species contained in plasma. Inside a plasma a rich set of chemical reactions takes place. SiH_4 is broken into SiH_3, SiH_2, SiH and Si, but these fragments can combine to form Si_2H_6, Si_3H_8, $(SiH_2)n$, etc. Chapter 9 suggests that SiH_3 may be an important intermediate that binds to dangling bonds at the surface of the film before losing its hydrogen. Mass spectroscopy and Langmuir probe measurements available to characterize a plasma are discussed in Chapter 10.

A knowledge of the structure of a-Si:H is important before one can proceed with an interpretation of optical and electrical properties of the material and before one can design variable devices. The structures are discussed in Chapters 11-14. Chapter 14 introduces the details of the many possible bonding configurations in a strained amorphous structure. Strained related defects can be frozen into the structure during deposition and form localized states that lie deep inside the energy gap.

This volume is useful to any scientist or engineer who is interested in the preparation and the structure in a-Si:H. This is a part of a four-volume miniseries devoted entirely to a-Si:H. The people who hope to understand optical properties, electronic and transport properties and device applications should study other volumes, Parts B, C, and D.

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Methods of Experimental Physics

Edited by Robert L. Park and Max G. Lagally

(Vol. 22. Solid State Physics: Surfaces, Academic Press, 1985)

The field of experimental surface physics is providing a cornucopia of research opportunities that is flowing over from the most fundamental and abstract realms into highly practical, applications-oriented areas. The rapid expansion and maturation of the field has been followed by the unwieldy growth of a copious literature. Periodic reviews that focus on particular developments are always welcome in such an atmosphere. This latest volume in the Celotta and Levine Methods series meets that need and provides a superbly executed tutorial treatise emphasizing the mainstream experimental techniques used by the modern surface scientist.

The volume is organized into nine chapters written by an impressive roster of 13 contributors, who are generally well known in their subfields. The areas represented are electron diffraction and spectroscopic techniques, ion scattering and sputtering techniques, field-emission and field-ion microscopies, work-function measurement techniques, and thermal, electron- and photon-stimulated desorption techniques. In addition to providing a solid base of information, including well over 200 figures and 1,000 references to the primary literature, an abundance of practical advice can be found, such as in an ion-scattering subsection (by H. Heiland and E. Taglauer) entitled: "To buy or not to buy, that is the question."

For those seeking a different level of poetry, there is the E. W. Muller quote that opens the high-field microscopies chapter (by J. A. Panitz): "It seems as if the evasive atoms still hide from the curious eye of the casual sightseer...." For the less casual student, more than half the volume is

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