

PREFACE

The area of plasma polymerization is now well recognized as an important part of material science. Plasma polymerization spans over several fields of science, namely chemistry, physics and extends in recent years to biology. This book is intended not for beginners but for advanced students, PhD students and researchers from both academia and the industry who are already more or less in the field. The authors of the book try to give the readers the present state of the art and future trends of plasma polymerization.

However, in the first chapter **Introduction**, the accidental reader, who never came across this field before, may obtain very basic information and is directed to more detailed and basic books and review papers. The definition of the term plasma polymer is given, deposition systems, process parameters and models of plasma polymerization are described.

The second chapter **Plasma deposition of fluoropolymer films in different glow discharge regimes** focuses on continuous, afterglow and modulated (pulsed) discharges and discusses active species in fluorocarbon plasmas. Diagnostics techniques, namely OES (Optical emission spectroscopy) and AOES (Actinometric optical emission spectroscopy) are described. Active species in fluorocarbon plasmas are presented and process parameters mentioned. The activated growth model is introduced and the applications of fluoropolymers briefly reviewed.

In the third chapter **Deposition of silicon containing films and FTIR diagnostics** (Deposition from organosilicon/oxygen mixtures), most of the attention is devoted to the $\text{SiO}_x\text{H}_y\text{C}_z$ (z, y are almost zero) film deposition processes: the nature of the most frequently used precursors and their physical characteristics; type of plasma generation and the description of certain reactors. However, a summary of the literature on $\text{SiN}_x\text{H}_y\text{C}_z$ is presented. The second part deals with the characterization of organosilicon — oxygenated gas mixture created plasmas. The principal species detected by the optical emission spectrometry, the mass spectrometry and the infrared absorption spectrometry (FTIR) are introduced. The application of FTIR in situ diagnostics is explained in more detail using the above examples.

In the fourth chapter **Corpuscular diagnostics of plasma polymerization processes**, experimental equipment for corpuscular diagnostics is described. Detection of neutral species and ions during the process are discussed in great detail. Examples are presented in terms of the discussion of particle fluxes to the growing film and the influence on the film morphology.

In the fifth chapter **Electrical and optical properties of plasma polymers**, at first, the electronic structure of plasma polymers, investigated by various methods, such as electronic spectroscopies, photoinjection, optical absorption, etc, is described. The idea of two types of plasma polymers, namely amorphous semiconductors and amorphous insulators is discussed. For general view both inorganic films (as a-Si:H) and organic films (deposited from organic precursors) are presented. The electric conductivity, its mechanisms, as well as carrier generation and transport processes are further discussed. Attention is also paid to practical applications of the films in electronics such as field-effect transistors and amorphous "superlattice" structures. Basic dielectric parameters of the films and their dependence on deposition conditions, post-treatment of deposited films, aging processes, and environment influences (e.g. humidity) are also mentioned. At the end optical properties of plasma polymers are briefly summarized.

The sixth chapter **Pulsed plasma polymerizations** describes fundamental aspects of modulated plasmas, discusses potential advantages and limitations of this approach, and provides a thorough review of work to date in this area.

One of the most important features of the pulsed plasma approach is the convenient and high level of film chemistry controllability it provides during polymer formation. The inherent compositional controllability afforded by this approach is illustrated in this chapter with data from several laboratories involving a variety of monomers. This chapter also identifies and discusses differences in several important plasma variables when contrasting CW and pulsed plasma polymerizations and the potential influences on these variables on the respective film formation processes. The chapter concludes with a brief review of current and future applications which take particular advantage of the molecular surface tailoring possibilities provided by the pulsed plasma surface modification technique.

In the seventh chapter **Stability of plasma polymers and plasma polymer coatings**, thermal stability of plasma polymers (also versus the stability of conventional polymers) is discussed. Chemical (including photochemical) stability of plasma polymers is presented. Mechanism of physical and chemical processes during storage and use (long term stability, environmental stability) is discussed in detail. Stability of coating systems (layer adhesion, interphase adhesion) is described in detail.

In the eighth chapter **Application of atmospheric discharge for plasma polymer processes**, the basics of the atmospheric pressure glow plasma (APG) are presented. The studies of the deposition process of mainly organic (plasma

polymer) films using emission spectrometry, IR absorption spectra and molecular beam (MB) mass spectrometry are described. The deposition system with parallel plate electrodes covered by glass insulator is described. Along with helium as carrier gas C_2H_4 and C_2F_4 , TEOS and some other monomers were used. Deposition processes for the first two monomers are discussed in detail.

The ninth chapter **Hard plasma polymers, composites and plasma polymer films prepared by rf sputtering of conventional polymers** pays attention at first to hydrocarbon plasma polymers and to the effect of energetic positive ion bombardment on the film hardness. Fluorocarbon plasma polymers are briefly mentioned. The basics of composite metal/plasma polymer films will be concisely presented: modes of their preparation, structure and morphology, anomalous electrical and optical properties. Composites: metal/hard plasma polymer and metal/hard carbon are described and their temperature and time stability compared to usual metal/plasma polymer composites.

Sputtering of polytetrafluoroethylene (PTFE) in argon and various gases as well as in self-sputtering mode is described. Composition of species in plasma volume and the growth of the fluorocarbon film in dependence on deposition parameters is discussed. The morphology (SEM), structure (FTIR, ESCA) and the electrical properties of the fluorocarbon plasma polymer films are described in detail. The main results in rf sputtering of polyethylene and some other polymers are briefly described.

The tenth chapter **Biomedical applications of plasma-deposited thin films** discusses the applications. The requirements for biocompatibility and how plasma deposited films meet those requirements are introduced. Following applications are described: Applications for cell culture, for controlled release of drugs, for biosensors, for implanted biomaterials and for contact lenses. Biorecognition and plasma-deposited films as well as patterned plasma deposited films are considered. In conclusion the perspectives are discussed.

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