XPS ANALYSIS OF FLUOROCARBON FILMS PRODUCED BY SPUTTERING OF A PTFE BULK CATHODE

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Polymer films were deposited on stainless steel substrates by RF sputtering from a bulk polytetrafluoro­ethylene cathode in various deposition conditions (gas pressure, gas composition, cathode self-bias voltage and cathode to specimen distance) : the surfaces of these sputtered films were then characterized by X-ray photoelectron spectroscopy in order to deduce information on their electronic structure and composition, as well as on the sputtering-deposition mechanism of the films.

This first systematic XPS analysis has shown that it is possible to sputter-deposit compounds whose surface properties (fluorine to carbon ratio, cross-linking and branching) can be varied over a large range of values, as it has already been observed for polymer films prepared by plasma polymerization. We note here that a film very similar to polytetrafluoroethylene

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has been grown at large distance from the discharge axis, and that all the prepared polymers were free of any oxygen contamination.

INTRODUCTION

During the last few years, the XPS (X-Ray Photoelectron Spectroscopy) technique has frequently been used and has proved to be the most successful spectroscopy to characterize surfaces of fluorine containing polymers. Indeed, the method provides valuable information concerning the different types of carbon present at or near the surfaces of these compounds\(^1\). To our knowledge, all the data available in the literature are related to fluoropolymers prepared by discharge in various gaseous atmospheres (plasma polymerization) or to stereoregular homopolymers\(^2\)-\(^13\). RF sputtering from a bulk fluoropolymer cathode is another preparation technique which can also be used to deposit polymeric material uniformly over large surface areas. These films were already studied by conventional techniques (Infra-Red, UV absorption edge, contact angle measurements\(^{14}-^{16}\)). These sputtered polymers present interesting properties: perfect inertness, good adherence, electrical and mechanical properties like those of bulk PTFE (polytetrafluoroethylene or Teflon)\(^\dagger\).

Therefore, the surface characterization of these sputtered polymers, and the investigation of the effects of selected sputtering conditions (gas pressure, gas composition, cathode self-bias voltage and cathode to specimen distance) on the structure and composition of these films were performed for the first time. Some information is also deduced on the mechanism of the sputtering-deposition of the films.

Teflon films are actually used in synthesis of selective membranes which could serve in desalination\(^18\), gas separation\(^19\) and gas sensors applications\(^20\).

EXPERIMENT

RF sputtering depositions have been done in a high-vacuum chamber (Figure 1) evacuated with a turbomolecular pumping unit. Background pressure prior to the introduction of argon, CF\(_4\) or Ar-CF\(_4\) mixtures was lower than 1.10\(^{-6}\) Torr (1 Torr = 133 Pa). In

\(\dagger\) Note added in proof:
Since this paper presentation, Dilks and Kay\(^17\) suggested briefly that a sputtered PTFE film is almost identical with plasma PTFE.