# Characterizing a Block Copolymer Surface with the PHI 06-C60 Sputter Ion Gun

## Introduction

Complex multi-layer organic structures are used to paint automobiles, deliver medication, and construct the visual display panels of the future. Research scientists developing these and other products have often struggled with existing analytical technologies to characterize multi-layer organic films. XPS has been successfully applied to characterize organic surfaces for many years, however the ability to sputter depth profile an organic structure has been severely limited by traditional inert gas sputtering and the chemical damage it causes. In the example shown here an annealed block copolymer was sputter depth profiled with the PHI 06-C60 sputter ion gun to test the validity of a proposed model for the structure that would be formed after annealing.
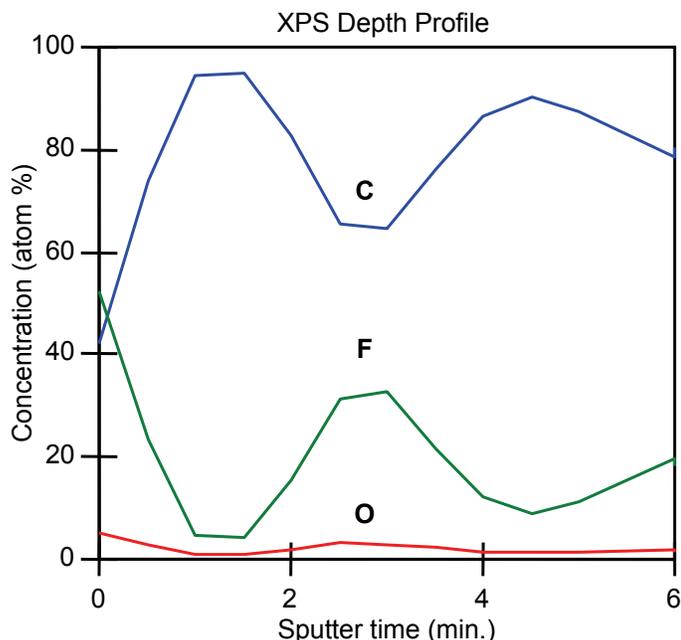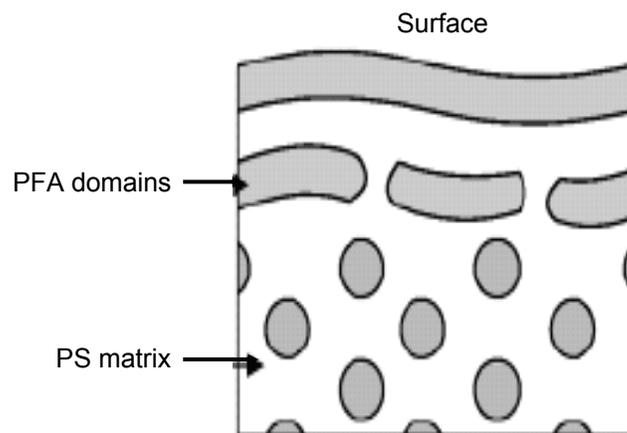


*Fig. 1 Proposed model of an annealed PS (polystyrene) and PFA (perfluoro-octyl-ethylacrylate) block copolymer showing a PFA enriched surface layer and arrays of tubular PFA domains below the surface.*



*Fig. 2 The XPS elemental depth profile shows evidence of a layered PFA structure after annealing the block copolymer film.*

## Experimental

A 200 nm PS – PFA film was spun cast on a silicon wafer and annealed for 24 hours at 423° K. A sputter depth profile was obtained using a PHI Quantera Scanning X-ray Microprobe to obtain XPS spectral data and a PHI model 06-C60 ion gun for sputtering. A 10 kV $C_{60}$ ion beam was rastered over a 2 x 2 mm area to create the depth profile.

## Results

The elemental sputter depth profile and chemical state information provide direct evidence to support the model shown in figure 1. The data also shows the ability of the PHI 06-C60 to sputter depth profile organic thin film structures and obtain valuable chemical depth distribution information from them.
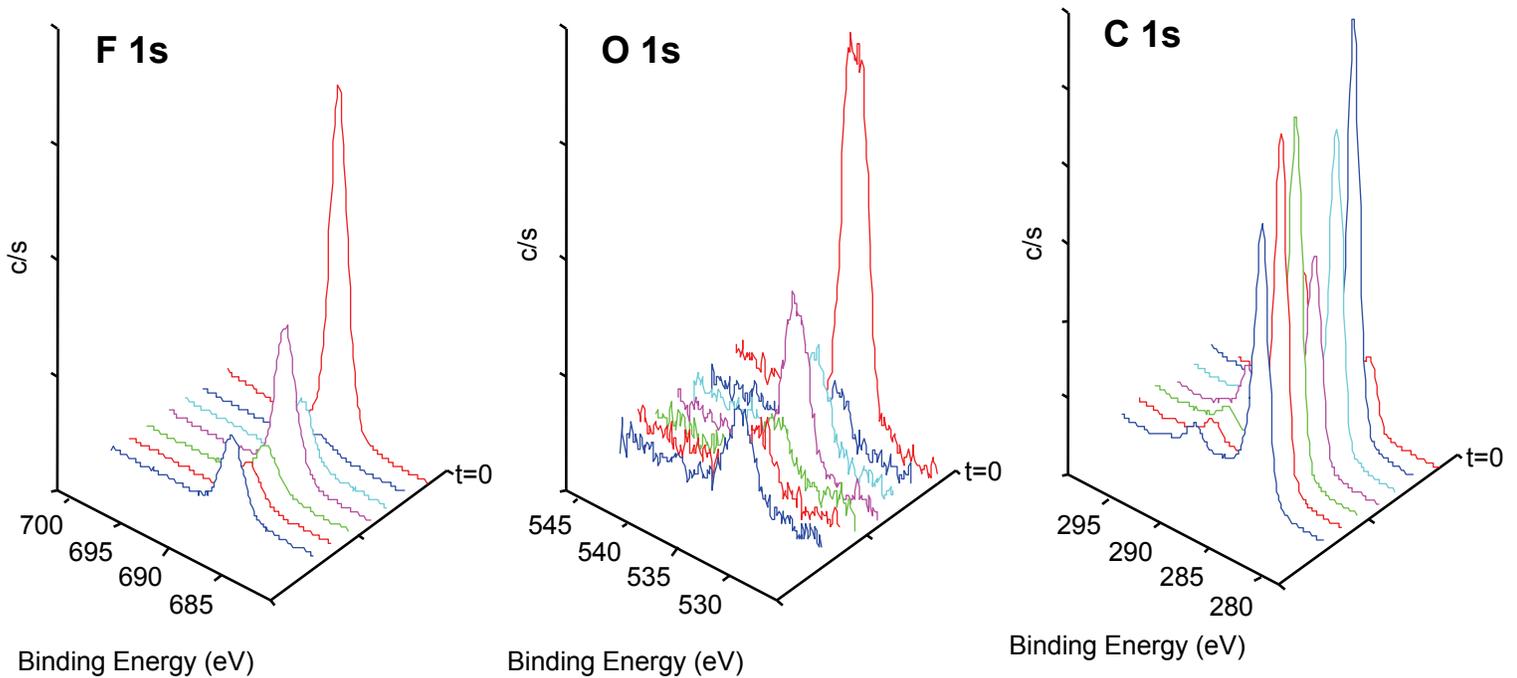
**F 1s**

c/s

Binding Energy (eV)

700
695
690
685

t=0

**O 1s**

c/s

Binding Energy (eV)

545
540
535
530

t=0

**C 1s**

c/s

Binding Energy (eV)

295
290
285
280

t=0

Fig. 3  XPS spectra show little evidence of chemical damage and indicate the presence of a layered PFA structure.

**Summary**

We have shown that a PHI Quantera Scanning X-ray Microprobe equipped with an 06-C60 ion gun can be successfully used to depth profile organic thin film structures and detect buried layers.  In the example shown here, the XPS depth profile provided evidence to support the validity of a model that predicted the formation of a layered structure after annealing a block copolymer.

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