

XPS and TOF-SIMS for the Pharmaceutical Industry

Surface analysis techniques which analyze the top few atomic layers of materials play an important role in the pharmaceutical industry. From production quality control to understanding surface interactions in biological systems, these analytical techniques are useful at all steps in the life cycle of a pharmaceutical for creating more effective products and processes. Examples where surface analysis provides benefits include:

- Contamination identification and quantification
- Imaging of tablet components-drugs and excipients
- Surface segregation and coverage
- Packaging analysis
- Purity and cleanliness validations
- Sterilization studies
- Reverse engineering/patent infringement

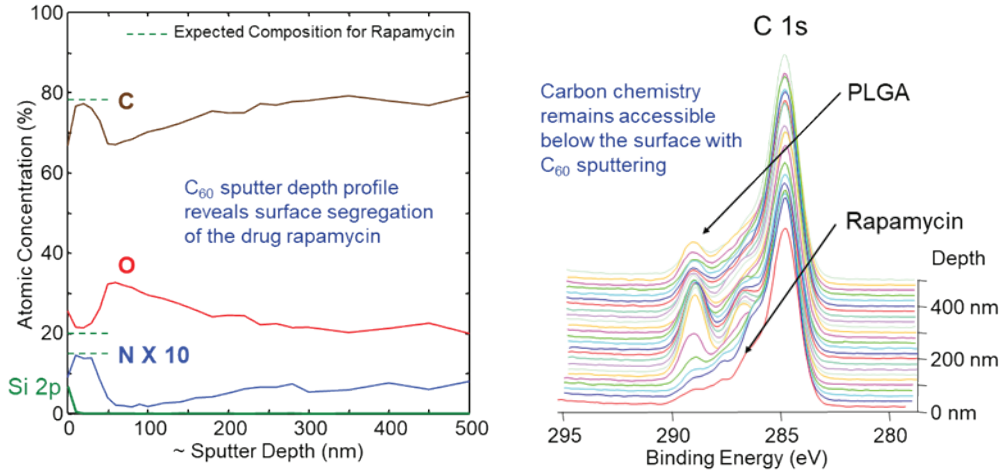
	XPS	TOF-SIMS
Probe Beam	X-rays	Ions
Analytical Signal	Electrons	Ions
Spatial Resolution	7.5 µm	0.07µm
Sampling Depth	1-10 nm	1-2 nm
Detection Limits	0.1-0.01 at %	PPM
Quantification	Excellent	Standards Needed
Information Content	Elemental Short Range Chemistry	Elemental Molecular
Organic Information	Yes	Yes
Depth Profiling	Yes	Yes

Attributes for XPS and TOF-SIMS are summarized in the table above.

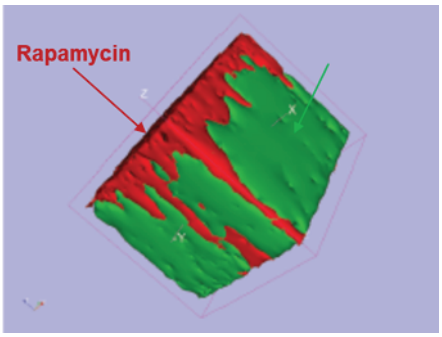
X-ray Photoelectron Spectroscopy (XPS) and Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) are two of the most commonly used surface analysis methods for studying pharmaceutical samples. The techniques are highly reliable and provide chemically specific complementary information:

- XPS provides quantitative analysis of elemental composition and short-range chemical bonding information. However, it may be difficult to distinguish large molecules that contain the same few primary elements.
- TOF-SIMS can distinguish molecular-scale components with high sensitivity, but requires standards for quantitive analysis
- Combined with cluster ion beams for organic profiling, XPS and TOF-SIMS can also provide 2-dimensional and 3-dimensional depth profiles and imaging.

XPS and TOF-SIMS depth profiles of a 50-50 Rapamycin-PLGA Coating

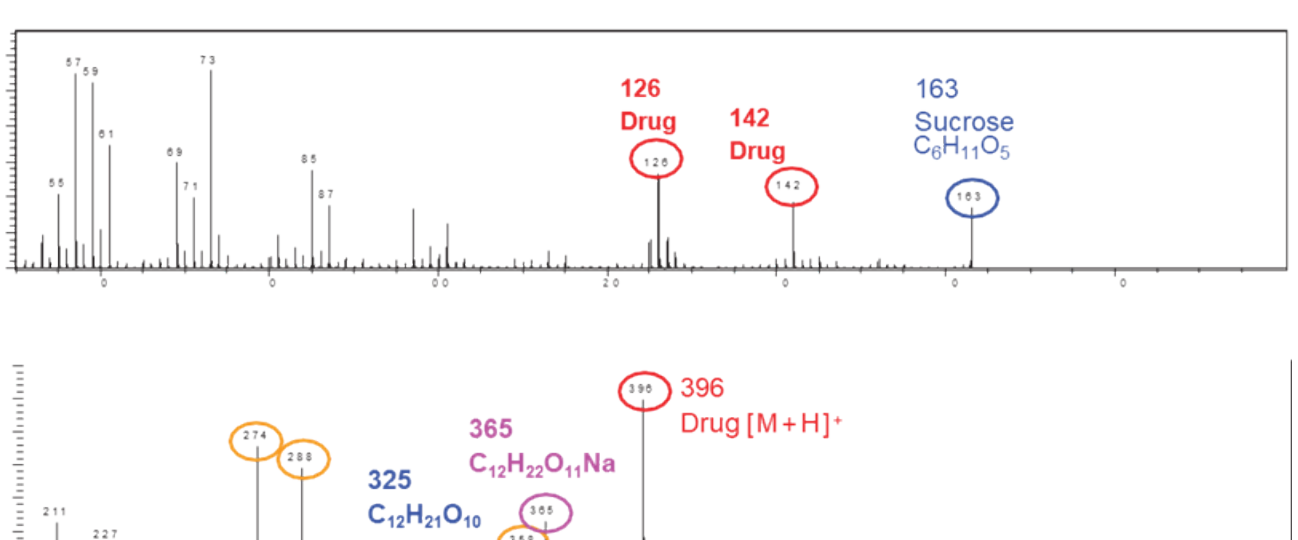


C60 XPS sputter depth profile and associated carbon spectra showing surface segregation of Rapamycin and short-range carbon chemistry of Rapamycin and PLGA

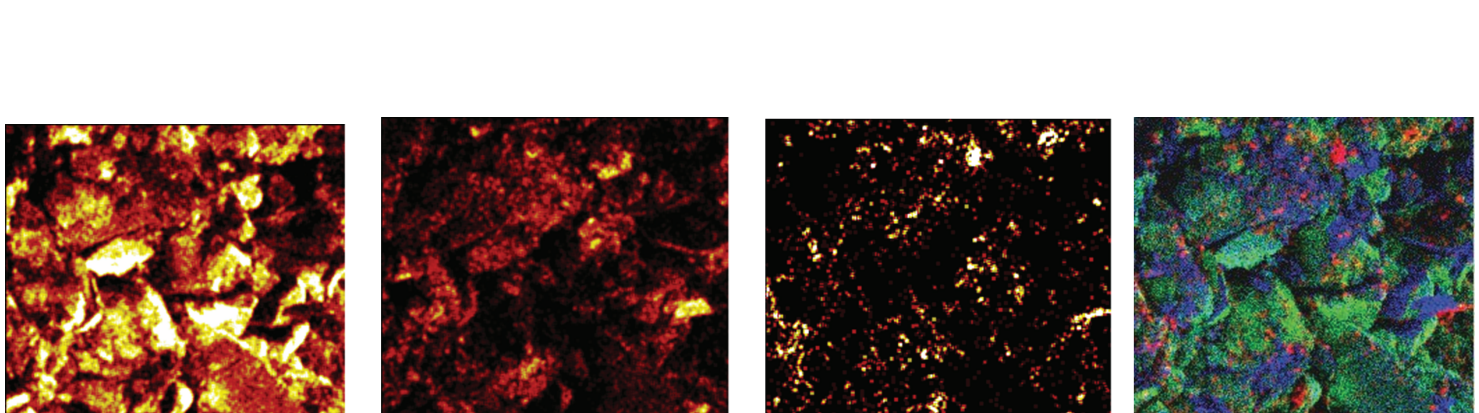


3D TOF-SIMS C60 sputter depth profile showing surface segregation and heterogeneity of the Rapamycin in PLGA

TOF-SIMS analysis of a drug granule cross-section



Positive ion TOF-SIMS spectrum of the drug granule cross-section showing the presence of the active ingredient as well as various additives



59 amu Binder

163 amu Excipient

365 amu Active Ingredient

Blue: Excipient Sucrose
Red: Active Ingredient
Green: Binder HPC

Mass images and superimposed image of the drug granule cross-section.
The scale bars are 10 µm (Field of view 50 µm x 50 µm).
The distribution of the active ingredient with spatial domains on the µm scale is observed.