New Developments for 3D Imaging with TOF-SIMS by FIB Sectioning

Gregory L. Fisher[1], Christopher Szakal[2], and Kenneth D. Bomben[1]

[1]Physical Electronics, 18725 Lake Drive East, Chanhassen, MN 55317, USA
[2]NIST, 100 Bureau Drive MS8371, Gaithersburg, MD 20899, USA

There are practical limitations to the use of ion beam sputtering for probing both organic and inorganic specimens beyond the surface region. Certain organic matrix components do not sputter well and are susceptible to ion beam-induced molecular damage. Accumulating beam damage results in deterioration of the molecular secondary ion signals. Furthermore, some organic and inorganic matrix components may sputter at a different rate than others, a condition of differential sputtering, which results in a misrepresentation of the elemental and molecular distributions. Even under optimized analytical conditions, the efficacy of sputter depth profiling an organic matrix to achieve 3D molecular imaging is limited to <5 μm in the case of a favorable chemistry and to <300 nm in the case of an unfavorable chemistry. In cases where the sample matrix is more complex, e. g., biological cells or tissues, the analytical difficulty increases dramatically. An alternative approach to achieve 3D molecular imaging with TOF-SIMS is to employ FIB milling and sectioning. Applying the FIB approach, 3D molecular imaging of large volumes may be achieved in far less time than would be required to perform a comparable sputter depth profile. Another advantage of the FIB-TOF approach is that the potential artifacts caused by sputter depth profiling, i.e., differential sputtering and accumulated ion beam damage to matrix molecules, are avoided.

The union of successive FIB sectioning and TOF-SIMS imaging to achieve 3D imaging will be discussed and illustrated using inorganic examples, and progress toward achieving 3D imaging of an organic matrix via the FIB-TOF method will also be discussed.