High sensitivity depth profiling of light elements in Si semi-conductor by specialized TOF-SIMS

Detection limits have enormously improved by customizing new TOF-SIMS instrument and developing analytical condition. The detection limit of H, C and O has reached to 10^{17}atoms/cm^3 level, moreover, it can be performed in the small area such as 15 μm square.

Depth profiles of impurities in the small area of a patterned sample with SiO_2/Si by TOF-SIMS

[Optical microscope image after TOF-SIMS analysis]

Measured area（14μm□）

25μm

[Sample structure]

Oxide film (200nm)

Si sub.

[Oxide and Interface]

Oxide | Si sub.

O, H, C, Cl, F, P, B, N, As, S, Si→

Detected at the interface

Concentration (atoms/cc): 1E+22, 1E+21, 1E+20, 1E+19, 1E+18, 1E+17, 1E+16, 1E+15

Depth(μ m): 0, 0.1, 0.2, 0.3

[Whole depth profile]

Si sub.

Oxide

Detected near the interface in Si sub.

Si→, H O, P B, C, N, S Cl As, F, P, As

Intensity (counts): 1E+06, 1E+05, 1E+04, 1E+03, 1E+02, 1E+01, 1E+00

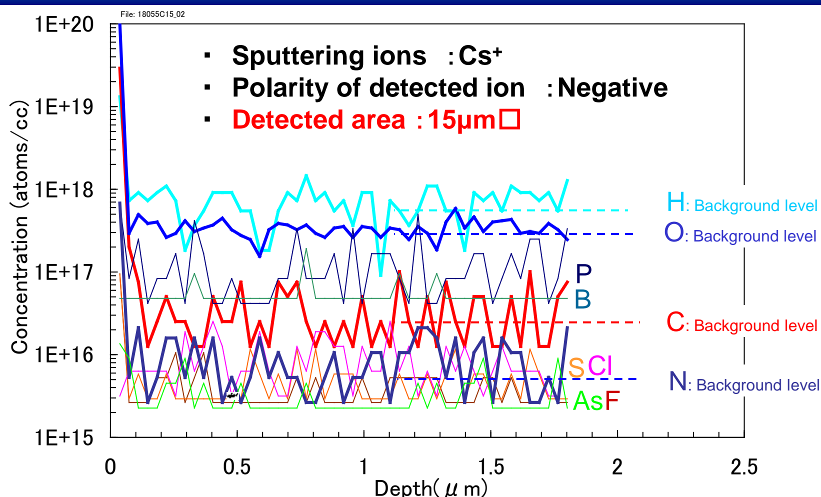
Depth(μ m): 0, 0.5, 1, .5, 2

Both depth profiles in the right side are originally derived form the same measurement.
In the right one, 10 data points neighboring in depth scale were accumulated.

Real depth profiles were obtained without mass interference.

Detection limits of H and O have been improved by 1～2 orders.
* All elements in Si sub. are detection limit or background level.

The confirmation of detection limit and background level of our TOF-SIMS by analyzing of FZ-Si sub.



Background level of light elements (atoms/cm^3)

- H：5×10^{17}
- C：3×10^{16}
- N：5×10^{15}
- O：3×10^{17}

Detection limit of other elements (atoms/cm^3)

- B：5×10^{16}
- P：1×10^{17}
- F, S, Cl, As：$3\sim5\times10^{16}$

By customizing TOF-SIMS instruments and developing analytical conditions, the high sensitivity depth profiling of light elements has been enabled at the small area of patterned Si sample .

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