



AN 427

Characterization of Amorphous Silicon Using Secondary Ion Mass Spectrometry (SIMS)

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Discussion

Impurity and dopant profiles in amorphous silicon are important aspects for a-Si(H) solar cell materials and a-Si TFT (Thin Film Transistors) for flat panel display applications. SIMS is a powerful analytical technique routinely used to monitor the various impurity and dopant profiles with very good precision and sensitivities. However, as thickness of amorphous silicon layer shrinks to improve device performances, it demands new protocols of SIMS analysis to face these new challenges.

EAG can provide:

- Accurate measurements of hydrogen concentration in wide concentration range: 1ppm to 30%.
- Improved detection limit for P: $1\text{-}2\text{E}+15$ atoms/cm³.
- Improved detection limit and depth resolution for atmospheric species for very thin a-silicon layers.
- Accurate calibrations for all species and matrix using ion implant standards.

Table 1: SIMS Detection Limits for Silicon under Normal Conditions

O ₂ ⁺ Primary Ion Beam Positive Ions		Cs ⁺ Primary Ion Beam Negative Ions		Cs ⁺ Primary Ion Beam Positive Ions (MCs ⁺)	
Element	DL (atoms/cm ³)	Element	DL (atoms/cm ³)	Element	DL (atoms/cm ³)
He	5E+17	H	1E+17	Ar	5E+16
Li	<1E+13	B	1E+15	-	-
B	2E+13	C	1E+16	-	-
Na	1E+13	N	5E+15	-	-
Mg	<1E+13	O	5E+16	-	-
Al	2E+13	F	5E+15	-	-
K	<1E+13	P	1E+14*	-	-
Ca	1E+13	S	1E+15	-	-
Ti	2E+13	Cl	5E+15	-	-
Cr	2E+13	Cu	1E+15	-	-
Mn	2E+13	As	5E+12	-	-
Fe	1E+14 – 2E+15	Ge	1E+15	-	-
Ni	5E+14	Sb	1E+14 – 1E+15	-	-
Cu	2E+14	Au	5E+13	-	-
Zn	5E+15	-	-	-	-
As	5E+16	-	-	-	-
Mo	2E+14	-	-	-	-
In	5E+13	-	-	-	-
Ta	1E+15	-	-	-	-
W	5E+14	-	-	-	-

* P detection limit is $1\text{-}2\text{E}+15$ atoms/cm³ when Si contains very high level (percent) of hydrogen.

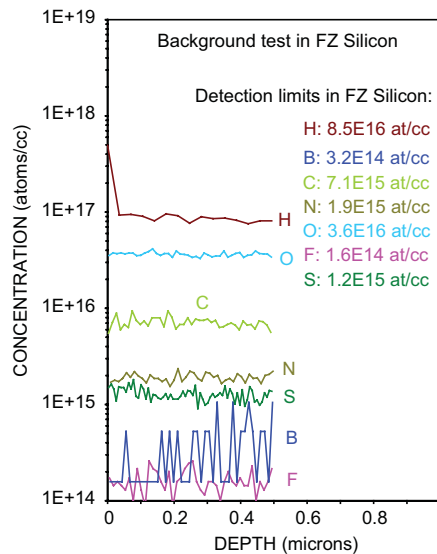


Figure 1: Depth Profiles for Selected Impurities in a Float Zone Silicon Under Condition for a-Si Measurements.

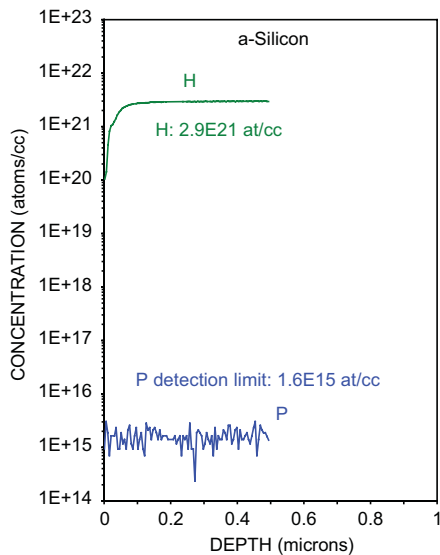


Figure 2: Depth profile for phosphorous (P) in an a-Si(H) sample heavily doped with hydrogen. The data show excellent detection limit for P.

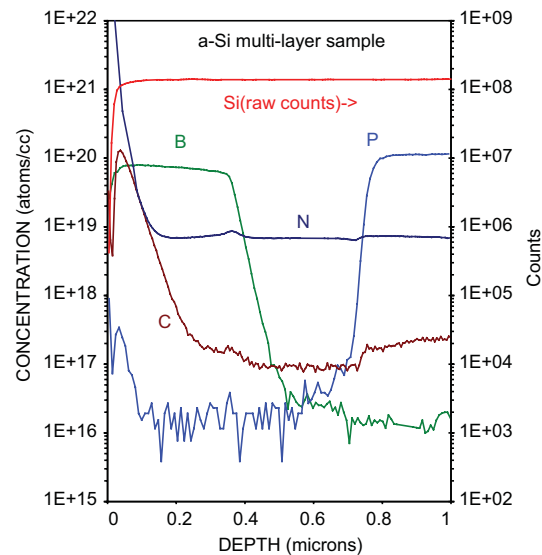


Figure 3: An example of multi-species SIMS depth profiles acquired from a multi-layer a-Si sample is shown.

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