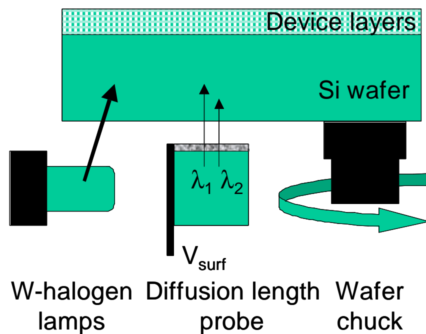
Metal Contamination Testing on Production Wafers: MC100

Principle of the Measurement

The MC100 metal contamination monitor uses surface photo-voltage (SPV) measurements in the backside regions of production wafers to measure metal contamination levels using ASTM F391a procedures. The method uses SPV values using two probe light wavelengths to calculate carrier diffusion lengths in the product wafer substrate. Carrier diffusion length is mapped over the wafer backside using an off-center chuck scanner (Fig. 1). After initial SPV scanning, the wafer is moved to a bright-light illumination stand, to dissociate metal-dopant pairs, and then the carrier lifetime is re-mapped with the SPV probe.



W-halogen lamps | Diffusion length probe | Wafer chuck

Figure 1. Sketch of the MC100 metal contamination measurement method.

If metal contamination is present in the bulk of the wafer, the carrier diffusion length is reduced after illumination due to the dissociation of metal-dopant pairs, releasing metal interstitials, which are more active carrier traps and recombination centers. The metal contamination levels are determined by the change in the carrier diffusion length.

$$[Fe] \sim 10^{16} [1/L_1^2 - 1/L_o^2] \text{ (atoms/cm}^3\text{)}$$

where,
[Fe] is the metal contamination level,
L_o: carrier diffusion length before illumination,
L_1: carrier diffusion length after illumination.

Metal contamination measurements can be made through backside dielectric films and thin (<0.1 um) poly layers. Metal levels can be quantified from $\sim 3 \times 10^9$ to $\sim 1 \times 10^{14}$ Fe/cm^3.

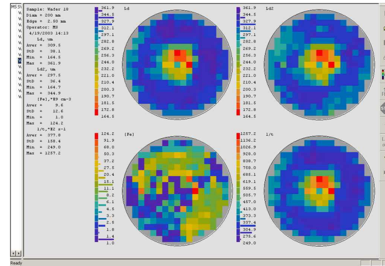


Figure 2. Maps of carrier diffusion before (upper left) and after (upper right) illumination, Fe distribution (lower left) and inverse of carrier lifetime (lower right) for a wafer with a metal level of $\sim 9 \times 10^9$ Fe/cm^3.

Specifications: (200 and 300 mm wafers)

Measurements:

Carrier diffusion length: 10 um to $\sim t_{wafer}/2$
Carrier lifetime: 0.03 to 300 us (p-Si)
0.08 to 800 us (n-Si)
Metals: 3×10^9 to $\sim 10^{14}$ Fe/cm^3
($\pm$ 4% at 10^{11} Fe/cm^3)

Throughput:

225 points/wafer mapping
Carrier diffusion length: 4 wafers/hour
Metals levels: 2 wafers/hour

Footprint:

300 mm FOUP: 1.16 (Width) x 2.01 (Depth) m
200 mm FOUP **0.76** (Width) x 1.58 (Depth) m

Options: *(for monitor wafers)*

1. Corona shower.

Backside charge deposition system to drive p-Si monitor wafers into inversion for surface oxide layers with large fixed charges.

2. Kelvin probe.

Front-side voltage sensor for characterization of plasma damage in dielectric films.

MC100 Metal Contamination Mapping Tool (single FOUP)

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