

Void Detection In Copper Interconnects Using Energy Dispersive X-Ray Spectroscopy

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ABSTRACT

Low-dimensional copper interconnects are prone to void formation which takes place during the Cu-filling of narrow interconnect lines. These voids increase the electrical resistance of the interconnects which in turn results in an increase of the RC delay of the integrated circuit. Therefore, a fast and non-destructive method is needed, which will allow the detection of the voids in copper interconnects at the early stages of their fabrication process.

In this work, we used Energy Dispersive X-ray Spectroscopy (EDS) on narrow copper lines (15-55 nm) as a non-destructive method to detect the presence of voids. The methodology used is based on the fact that within EDS, the intensity of the characteristic X-rays (for Cu) is proportional of the amount of Cu-atoms present within the interaction volume. Hence, for thin and polished Cu-lines where absorption effects can be ignored, a decrease of the copper signal during an EDS line-scan along the copper interconnect line can be translated into a reduced amount of Cu i.e. the presence of a void.

Using this methodology we have been able to identify the presence of <10 nm voids within 15-30 nm lines (see Fig. 1). A sensitivity analysis based on the S/N ratio of the system and the volume fraction of the void relative to the line width and height, demonstrates that the technique is primarily suited for void detection in narrow lines (>50 nm) whereas for larger dimensions the relative intensity variation due to the presence of the void, becomes too small.

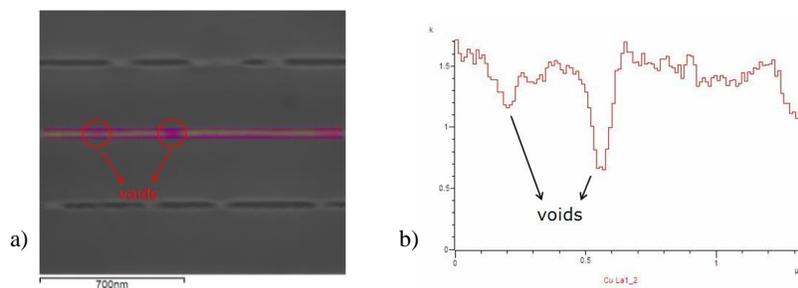


FIGURE 1. a) EDS mapping of the 15 nm Cu-line; Cu is illustrated with green color and SiO₂ with magenta. b) Line-scan of the Cu-line where the Cu signal is displayed. On both images, the two voids are clearly detected.

Keywords: Copper interconnects; EDS; Void detection

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