EAG[SM] Evans Analytical Group

AN 418
Backside SIMS

May 7, 2007 (Version 2.0)

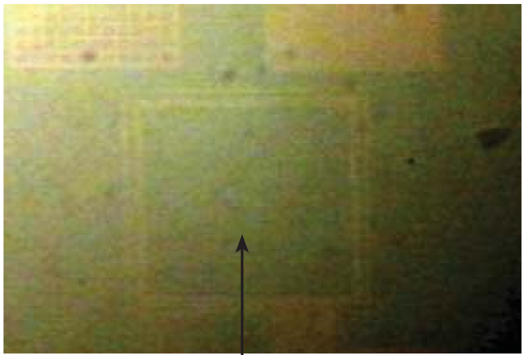
Discussion

Backside SIMS is a new way to do dynamic SIMS depth profiling on samples which have been carefully polished from the reverse of the wafer up to an appropriate depth below the active device region on the original wafer surface. In SIMS applications, there are several restrictions that affect the possibilities of obtaining high quality SIMS data. One of these is the ultimate depth of the analysis. In many cases this is restricted to 10-20µm, due to sample roughening, crater edge effects amongst others. Another restriction is that the species of interest should not be present as a major component above a layer of interest where it may be present as low-level contaminant.

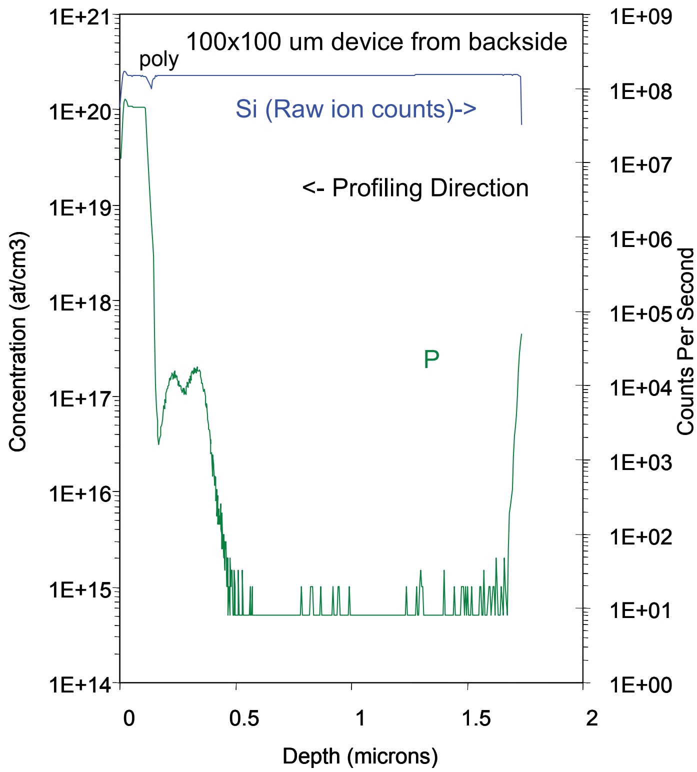
To address these restrictions, Evans Analytical Group has developed a polishing/sample preparation technique that allows samples to be analyzed that were previously very difficult to analyze without compromising data quality. No matter what the layer of interest (or its surrounding layers), SIMS can now be done on that layer after suitable sample preparation and/ or polishing

Backside SIMS Analysis of A Heavily Phosphorus Doped Structure

The correct phosphorus distribution could not be measured from the frontside in a device with a high level of phosphorus (0.2%) in the upper polysilicon layer. However, after polishing the sample from the backside of the wafer, and subsequent SIMS analysis from the backside, then the phosphorus distribution in the substrate below the polysilicon could successfully be measured.



Optical image of the polished sample (from the backside) prior to SIMS analysis. The analytical area of interest can clearly be seen and is about 100µm × 100µm in size.



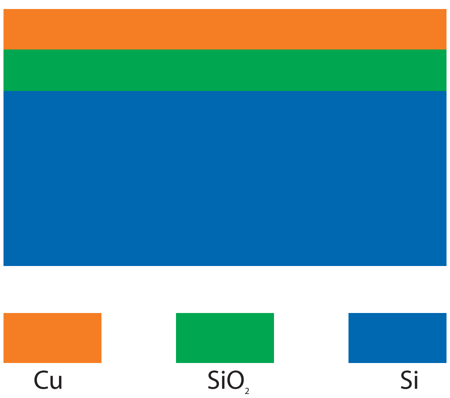
SIMS backside depth profile showing phosphorus distribution, up to 2×10^{17} at/cm^3, within the substrate below the polysilicon surface layer.

Backside SIMS for Copper Diffusion Measurement

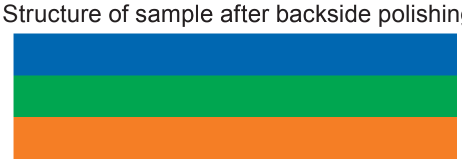
Copper is known to diffuse readily in electronic devices. For this reason it is often necessary to use barrier materials to reduce copper diffusion through dielectrics such as silicon dioxide. This application note details the use of sample polishing and backside SIMS to determine the amount of copper diffusion observed through a sample with no barrier.

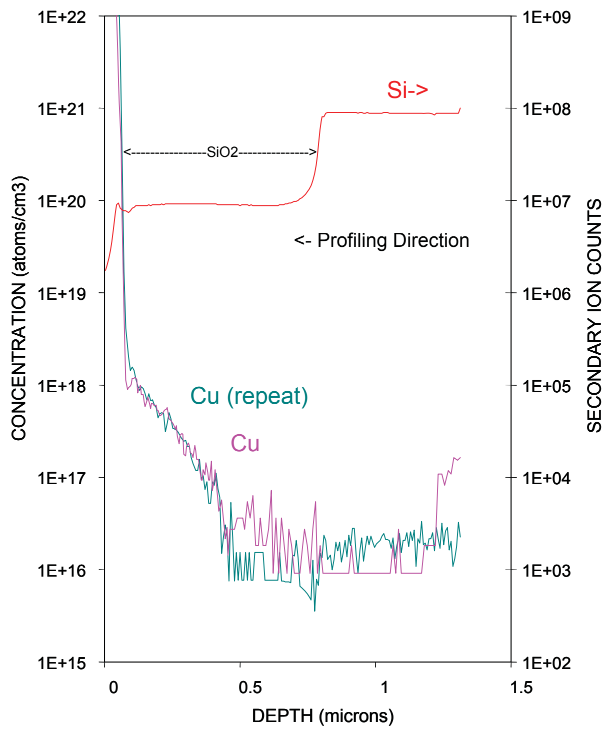
Profiling from the top down through the copper layer is not a good way to investigate diffusion using SIMS since some of the copper from the upper layer will be driven into the lower dielectric layer, thus obscuring low levels of diffusion. Profiling from the backside, through the Si, followed by the SiO_2 and then the Cu layer means that there will be no 'memory effect' of a prior high level of copper, so any copper observed will be genuine, in terms of it's location and concentration. Using this method, diffusion can successfully be investigated through samples which have been processed or stressed differently and comparisons of barrier layer effectiveness can also be made.

Sample structure surface



Structure of sample after backside polishing





The SIMS profile above shows the distribution of copper measured after backside polishing. The profiling directions was from right to left. Copper diffusion is clearly observable from the copper layer into the silicon dioxide. A repeat profile shows that this diffusion was measurable reproducibly.

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