THIN ONO LAYERS

In DRAM industry, upgrading the storage capacity used to be one of the major goals of the R&D. For its achievement, materials with high dielectric constant resulted to be the state-of-the-art. The related technology now focuses on the use of thin ONO (Oxide / Nitride / Oxide) stacks which necessarily tend to be thinner and thinner to enhance capacitive performances.

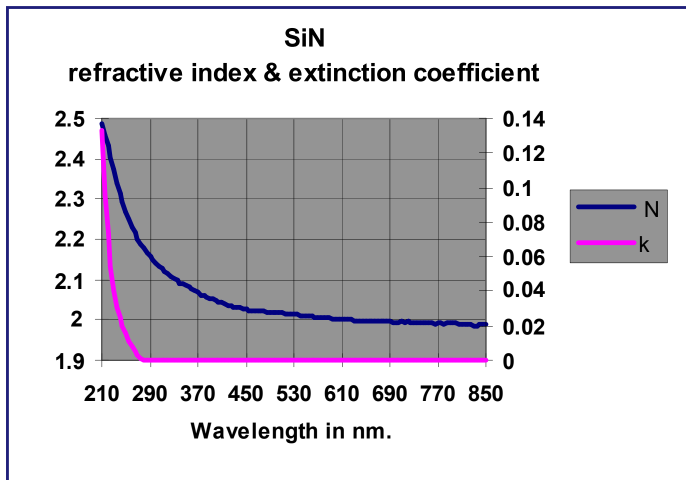


Figure 1

Up till now, most of the optical techniques can only measure the thickness of the stack considered as a whole or determine the different thicknesses by taking out one of the oxides from the fit.

Since the thickness of each layer is difficult to be measured independently, the ONO structures show the tremendous need to take measurement using **Spectroscopic Ellipsometry** by **SOPRA** especially in the UV range.

Indeed, in this part of the spectrum, the extinction coefficient 'k' for the Nitride increases (see Fig 1). Thus, the three thicknesses of the ONO stack can be decorelated using **SOPRA**'s technique. The refractive index of the Nitride has been determined independently on a single layer sample.

Spectroscopic Ellipsometry (SE) measures **two parameters :** the amplitude TanΨ and the phase CosΔ. CosΔ is, on ONO samples, much more sensitive than the amplitude. As an example, any small change in Nitride thickness can be detected (see Fig 2).

These curves focus on the need to take measurement with **SOPRA** Spectroscopic Ellipsometers to characterize with an uncomparable accuracy the very thin multilayer stacks, in terms of thickness of each layer.

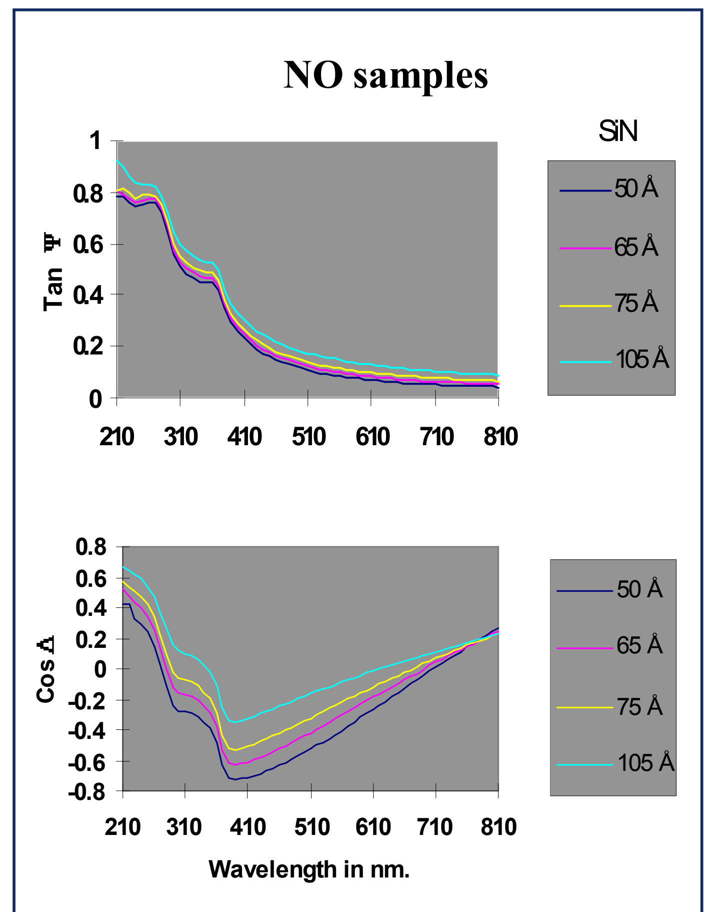
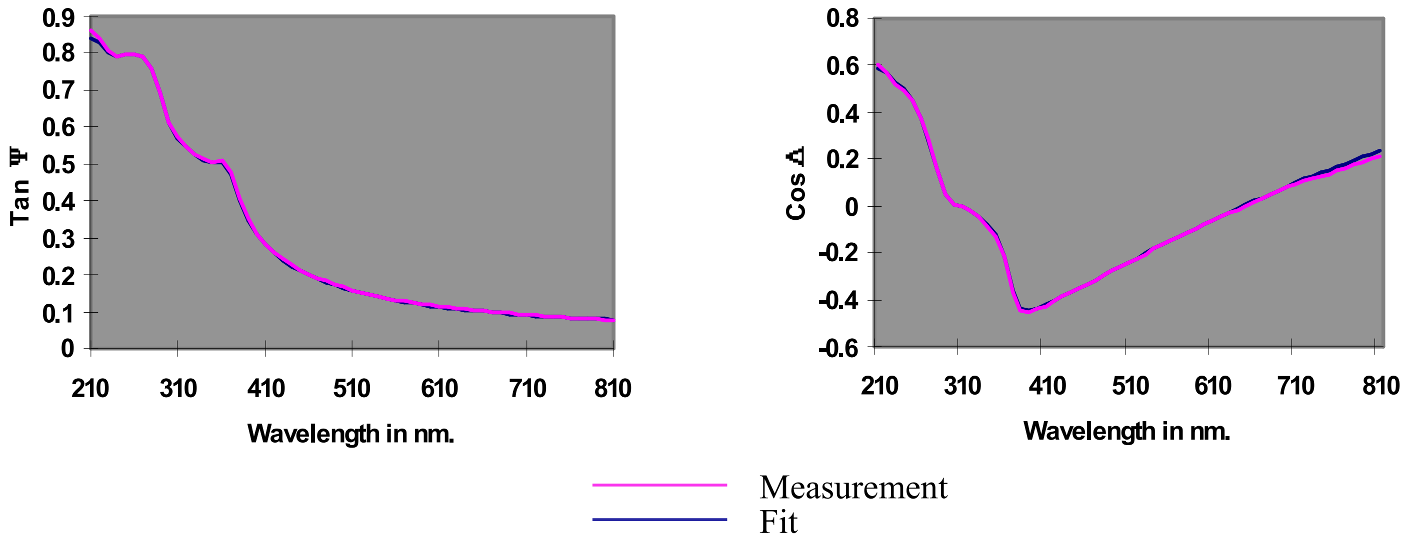


Figure 2

The example hereafter, shows the characterization of a thin ONO stack deposited on Silicon substrate.

The measurement has been implemented with the scanning mode of **SOPRA**’s **Multi Layer Monitor (MLM)**.

Measurement



MODEL

S i O 2	2 0 Å
S iN	6 0 Å
S i O 2	1 0 Å
S I	

The model used to fit the experimental measurement has been defined as shown on the left hand schematics. This structure is an approximate estimation of the sample structure.

ACTUAL STRUCTURE

S i O 2	1 3 Å
S iN	6 3 Å
S i O 2	1 8 Å
S I	

After running the regression software, the fit and the experimental curves are both displayed as shown above.
Eventually,the quantitative results can be read on a separate chart. Thicknesses from the chart have been reported to the left hand diagram as a mere illustration.

Using SOPRA’s MLM Spectroscopic Ellipsometer down to 210 nm in the UV range, the thickness of any ONO stack can be determined and controlled with a repeatability less than 1 Å for each layer.
The same kind of measurement and results can be obtained on similar multilayer samples such as ONOPO stacks (ONO on Poly on Oxide).

In addition, The use of ONO stacks on rugged-Poly to increase the area of the capacitor has been already characterized with MLM by SOPRA.

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