Spectroscopic reflectance measurement of ion-implanted aSi

Ion implantation of Si wafers is widely used to create doped areas/ device junctions. During implantation, Si is fully amorphized when the critical dose is reached. It is, subsequently, annealed to remove defects and activate the dopants.

It is necessary to measure the thickness of the implanted layer in order to fine tune the implantation process and for quality control. The measurement is done after implantation (before annealing) - amorphous Si layer is damaged and its optical constants maybe quite different from a standard aSi. So, both optical constants and thickness need to be measured, in most cases.

MProbe™ UVVisSR spectroscopic reflectometer (200nm -1000nm wavelength range, thickness range: 1nm -20µm) can be successfully used for this measurement.. In case of very thin doped layer (<10nm) the change of optical constants is relatively small and standard aSi material can be used in the measurement model (Fig. 1). For thicker aSi layers the use of standard optical constants does not give good results (Fig. 2).

In this case, Tauc-Lorentz approximation can be used to represent optical dispersion of aSi and determine actual optical constants and thickness of the layer (Fig. 3). Comparison of standard and measured optical constants (Fig, 4.) shows that the difference is significant. The main factor affecting optical constants is ion implant induced damage since doping concentration and the type of the ion has small effect on optical constants (in 200-1000nm wavelength range). Analysis of the measured results shows that the use of standard aSi optical constants for measurement of the 20nm -50nm aSi doped layers gives ~ 5nm thicker reading.

The use of MProbe™ UVVisSR provides fast, reliable and economic way of measuring the thickness of ion implanted layer. The measurement time (one point) is below 100ms. The measurement can be done using desktop (current example) or in-situ system.

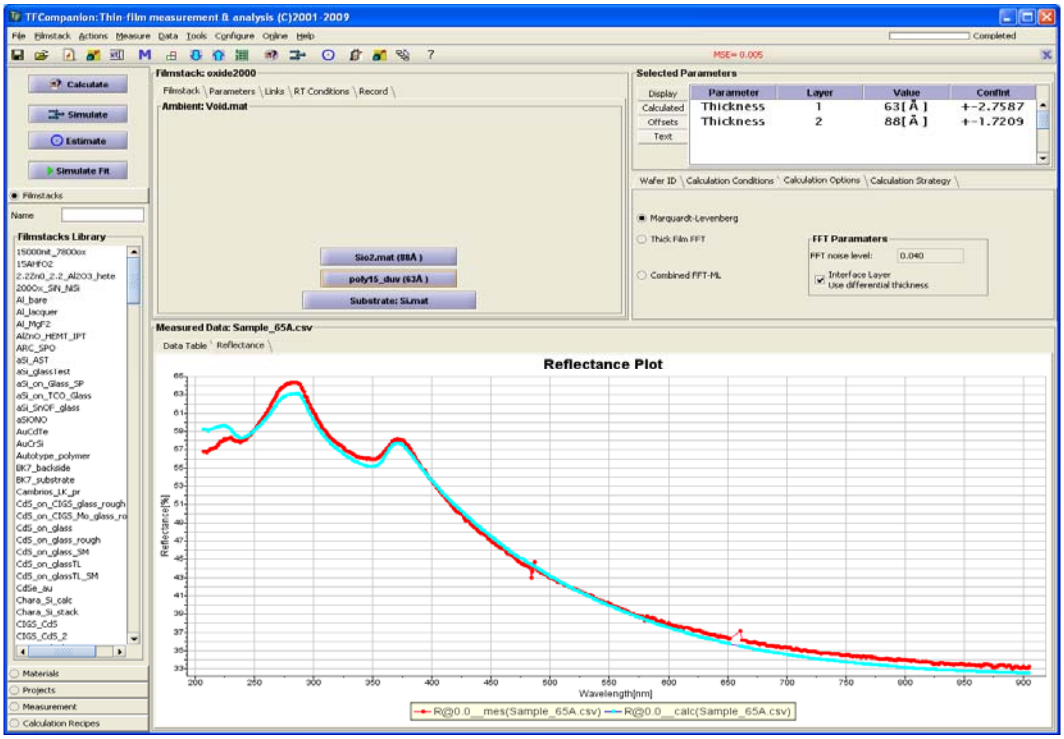

Fig. 1. Measurement of the thin (63 Å) ion-doped aSi layer. Optical constants of standard aSi are used in this case. Measured spectrum (red) vs. model (blue) shows good fit.

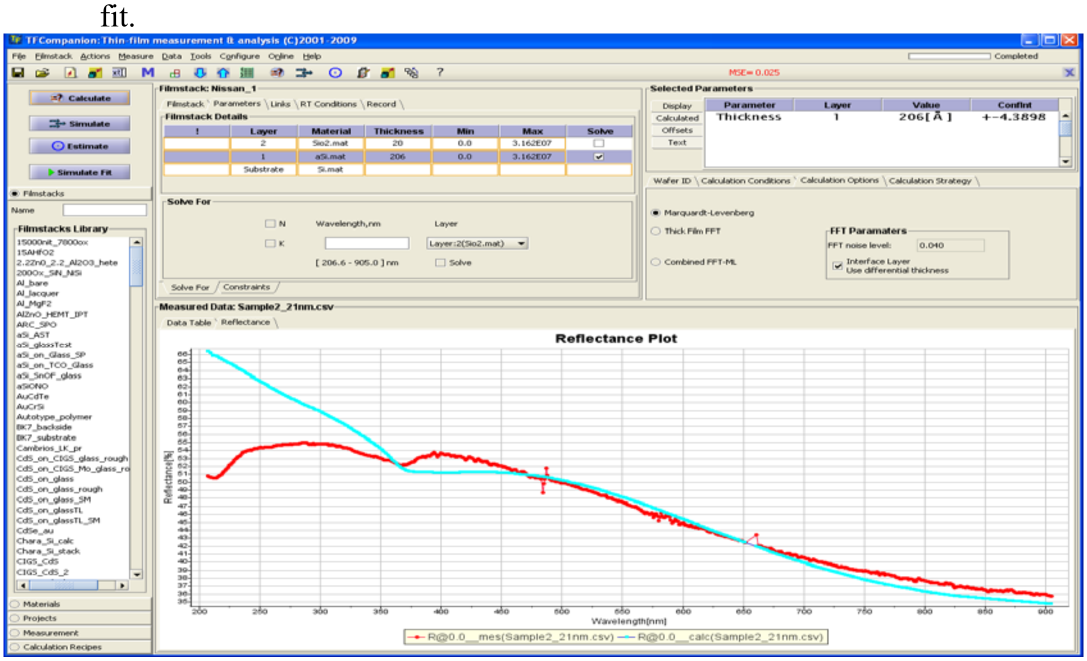

Fig. 2 Measurement of the thicker layer (160 Å) ion-doped aSi layer. Optical constant of standard aSi are used in this case. Measured spectrum (red) vs. model (blue) shows discrepancy in the UV region.

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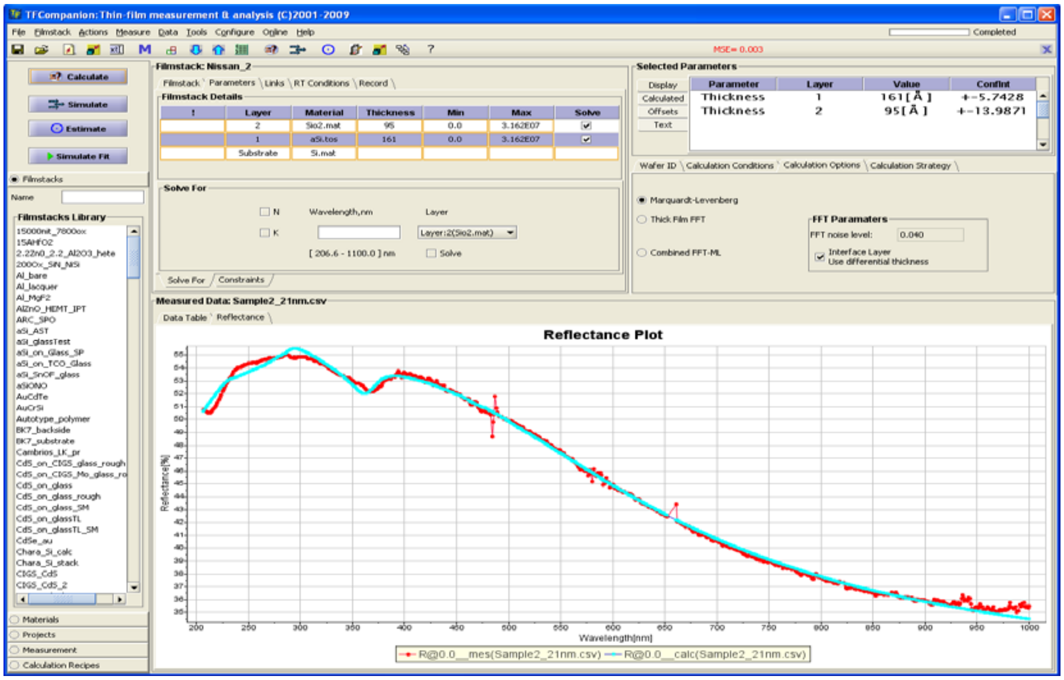

Fig. 3 Same measurement as Fig.2 but optical constants are represented using Tauc-Lorentz approximation. Measured spectrum (red) vs. model (blue) shows good fit. Both thickness and optical constants are measured.(see Fig. 4)

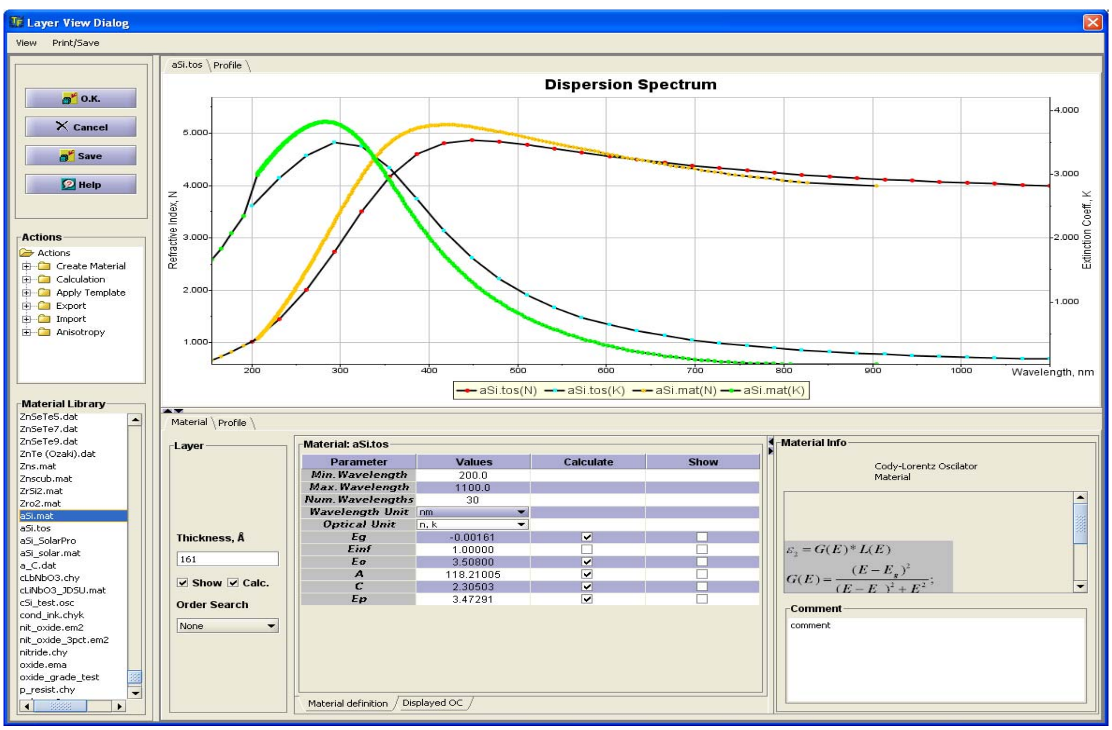

Fig. 4. Comparison of measured n & k (black lines) and standard aSi n&k.

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