# Infra Red Spectroscopic Ellipsometry, instrumentation and semiconductor applications

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Spectroscopic Ellipsometry (SE) is commonly used to characterize thin layers in the UV - Visible spectral range. In the Infra Red (IR) region, several materials become transparent like the silicon and many new information can be extracted as the molecular absorption bonds, the active dopants, concentration and depth, thus the resistance of the thin conductive layers. Because of the wavelength, small features do not diffract, then deep trenches, STI and vias can be measured. The instrument optical mounting will be presented, as well as the advantages versus simple IRTF reflectometers. In order to accomodate the modeling, the rear face reflection has been avoided. Actual performances and application examples in the field of semiconductors will be emphasized.

In the past years, the thin films were measured by visible reflectometer then with single wavelength ellipsometer, recently, spectroscopic ellipsometer has gathered in the same time the spectral range of the spectrophotometer and the advantages of the ellipsometer. Now the deep UV range is covered down to the limit of transmission of air, 190 nm. Using VUV, it is possible to reach 140 nm. The applications are for photolithography, very thin layers and particularly high K gate oxides . On the other part of the spectrum, in the lower energy range, from 0.6 to 0.07 eV or 2µ to 18µ or 5000 cm-1 to 650 cm-1, new and complementary information can be extracted as the molecular bonds which are finger prints of the materials, particularly the low K materials. The active dopants behave like a conductive material which has a defined thickness, thus IRSE can measure the sheet resistance of heavy doped epilayers as well as thin metals and barriers.

The advantages of SE versus reflectance measurements will be presented, particularly no purge nor reference sample or spectrum is needed.

A description of a fully automatic equipment, with robotics, prealignment, auto-focus, pattern recognition, small spot (85 x 200 µm) will be described, and several major applications, taking advantage from the infra-red spectral range, they are: ultra shallow junction, USJ, heavily doped selective epitaxial layers including silicon germanium, semi-metallic and thin metallic layers, high k and low k dielectrics, composition, porosity and thickness. Then, deep trenches and poly recess where scatterometry in the visible does not work.

New developments and actual improvements in term of speed and signal/noise ratio will be presented.

A new IRSE instrument is presented with several applications, particularly in the field of semiconductors. The advantage of physically canceling the rear face reflection of transparent Si wafers is that the modeling can be applied in any cases. The Spectroscopic Ellipsometry applied in the IR range will open many new possibilities for the characterization of semiconductors in the automatic in line mode on real pattern wafers.

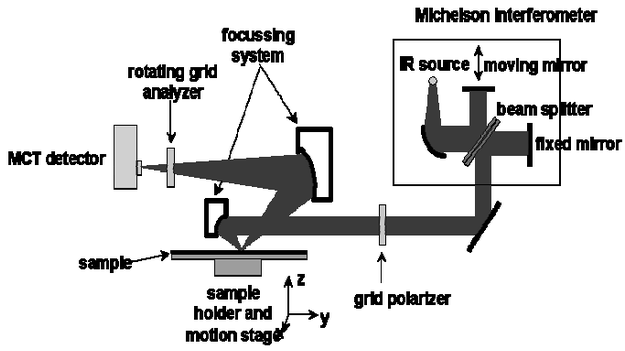


Figure 1: IRSE - system set-up

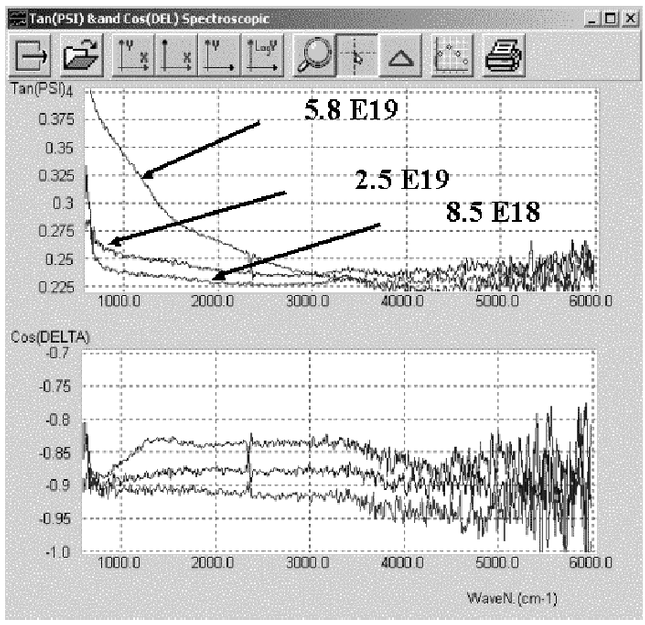


Figure 2: Boron doped SiGe layer measured by IRSE