Infra Red SE for FPD Industry

I - Infra-Red Spectroscopic Ellipsometry measurement for FPD Industry :

Fourier Transform Infra-Red Spectroscopy (FTIR) is a technique widely used for Thin Film compositional analysis . It is of key interest for various TFT-LCD technologies, like **Amorphous Silicon** and **Poly Silicon** TFT-LCD Displays .

FTIR spectrometers are commonly analyzing Thin Films deposited on Silicon wafers . This configuration is not convenient for TFT-LCD applications because it is a destructive measurement (Thin Film must be deposited on a wafer in a dummy CVD run with an equipment processing glass panels) .

SOPRA has developed a **FTIR Spectroscopic Ellipsometer** (FT-IRSE) that provides same information **directly on TFT glass panel** .

II - FT-IRSE applications for TFT-LCDs

FT-IRSE is a powerful technique that can measure simultaneously:

- Thin Film Thickness (single or multilayer samples) (cf. Figure 1),
- N & K in the IR spectral range (1.7 - 16µm)
- Molecular Bond Absorption

FT-IRSE allows to extract the following parameters of interest for TFT-LCDs :

1) amorphous Silicon TFT-LCDs :

- Si-H and N-H relative content in SiNx:H (cf. Figure 2);
- Hydrogen content in a-Si:H. Figure 2 displays a typical measurement made on a 4000Å a-Si:H layer. Fit is performed on Si-H and Si-H2 molecular absorption peaks (respectively at 2000 and 2100cm^{-1}) in order to extract Hydrogen content in At.% ;
- OH content in SiOx films;
- Sheet Resistance monitoring of ITO films.

2) Poly-Silicon TFT-LCDs:

- Monitoring of H content in aSi prior to and after recrystallization (by Excimer Laser Annealing or other technique). (cf. Figure 2).
- Monitoring of gate oxide composition (TFT stability control) .
- Monitoring of Dopant concentration after Ion Doping or Implantation and Dopant activation.

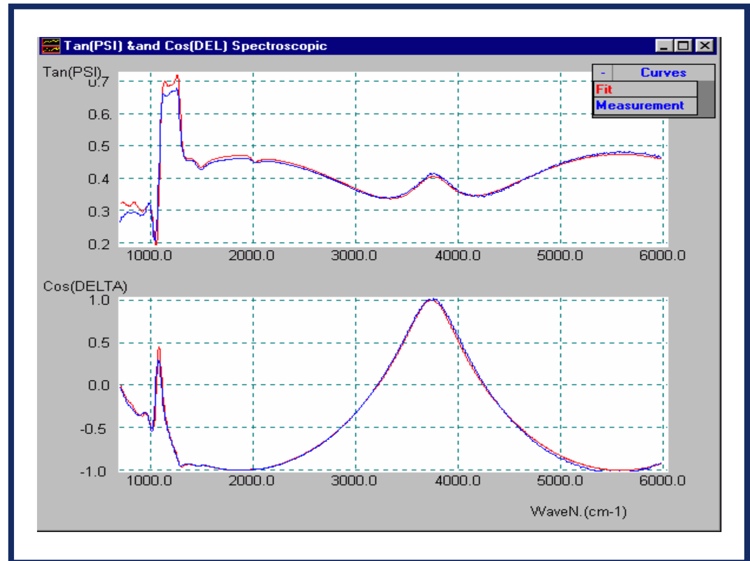

Figure 1. aSi:H/SiOx/Glass. SE spectrum and fit.

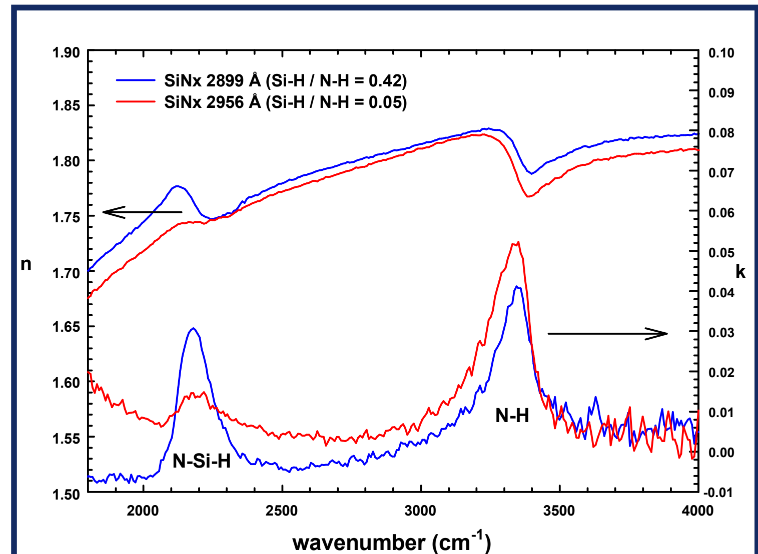

Figure 2. Comparison between Si-H rich and N-H rich SiNx layer.

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III - 4 key advantages of FT-IRSE over classical FTIR

1) FT-IRSE is an absolute technique, that does not require any reference substrate nor any reference measurement ;

2) Thin Film Thickness is extracted simultaneously with material compositional properties . This leads to better repeatability and reproducibility in compositional analysis results as compared to other absolute techniques like SIMS or ERDA .

3) FT-IRSE can determine materials composition of thin films in multi-layer stacks (cf. figure 1)

4) FT-IRSE provides better sensitivity than classical FTIR due to larger optical path inside Thin Film (wide incidence angle combined with reflection mode). Very Thin Films can be measured with FT-IRSE (like Hydrogen content measurement in 500Å a-Si:H films) .

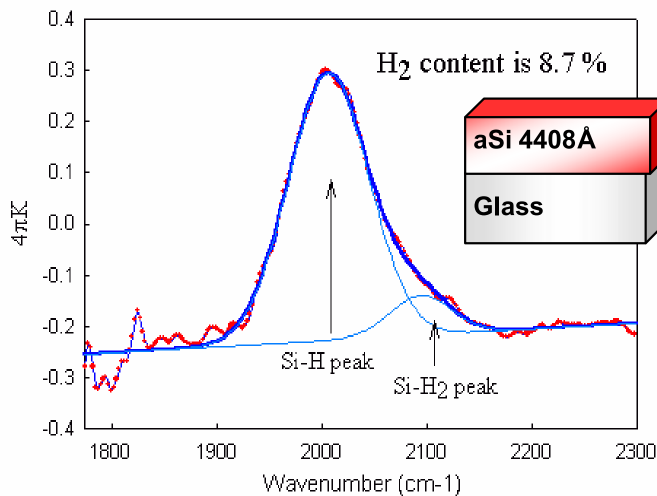

Figure 3. FT-IRSE measurement of Hydrogen content (at%) in a 4.4 kÅ a-Si:H film.

FT-IRSE Specifications :

- ***Spectral range :*** *650 - 6000 cm^{-1}*
- ***Resolution :*** *1-32 cm^{-1}*
- ***Minimum Box size :*** *1mm x 1mm*
- ***Incident angle :*** *from 60° to 75°, selectable*
- ***Measurement time:*** *typically 2min*
- ***Hydrogen Content Repeatability (a-Si:H & SiNx:H) :*** *± 0.3 At%*
- ***ITO Sheet Resistance:*** *$R \leq 200\ \Omega/$*

IV - Conclusion

FT-IRSE is supplied as an option to the standard SE-FPD tool that is already monitoring Thin Films thickness and optical properties in the DUV and Visible Spectral range (190-850nm) for TFT-LCD applications .
FT-IRSE provides a new metrology capability to the TFT-LCD Industry that is non-destructive and that can be implemented On-Line on real TFT Glass Panels .
FT-IRSE achieves better repeatability and reproducibility than classical FTIR on wafers .

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