

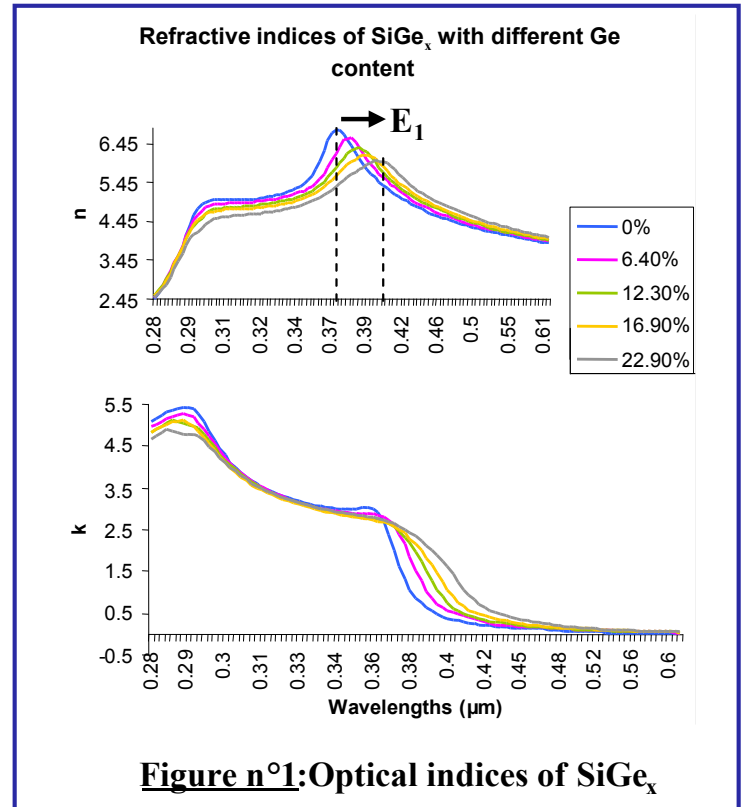
## Silicon Germanium ( $\text{Si}_{1-x}\text{Ge}_x$ )

With the development of the microelectronics, the epitaxial structures of semiconductors become more and more complex.  $\text{SiGe}_x$  system is widely studied for high speed heterojunction transistors (HBT). Indeed the insertion of  $\text{SiGe}_x$  in bipolar transistor produces higher cut-off and maximal frequencies (around 100 GHz) and simultaneously reduces the noise and power dissipation. These devices, when incorporated into RF or microwave components, make  $\text{SiGe}_x$  a strong competitor to GaAs.

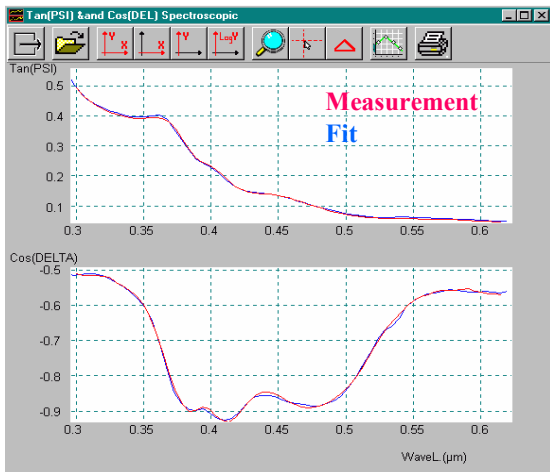
The need of precise characterisation technique capable to determine at the same time the thickness and the composition of such samples is obvious.

**Spectroscopic Ellipsometry(\*)**, which is **contactless, non destructive and allows on-line control**, is an excellent technique to perform such characterisation.

Figure 1 shows several  $\text{SiGe}_x$  refractive indices with different Germanium contents determined with one of the **SOPRA Ellipsometers**. The optical properties of these materials depends on the composition; as shown in figure 1, the position of the optical band gap  $E_1$  shifts with the Ge content  $x$ .



**Figure n°1: Optical indices of  $\text{SiGe}_x$**



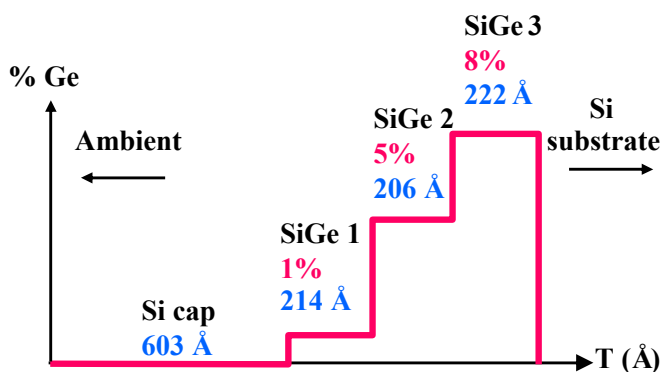
**Figure n°2-a :  $\text{SiGe}$  measurement**

Figure 2-a shows the measurement, taken in scanning mode, of typical  $\text{SiGe}_x$  structure (Si cap /  $\text{SiGe}_x$  graded / Si).

After running SOPRA's regression the best fit and the experimental curves are presented. The excellent agreement between the measurement and the model is to be seen.

Figure 2-b presents the structure of the sample and the results obtained.

From the measurement of two parameters (Tan $\Psi$  and Cos $\Delta$ ), **Spectroscopic Ellipsometry(\*)** can easily determine **at the same time and independently the thicknesses of each layer within the stack as well as the Ge content of the three  $\text{SiGe}_x$  layers and so, to characterise the shape of the graded layer.**



**Figure n°2-b : Typical  $\text{SiGe}_x$  graded structure with cap**

(\*)Refer to SOPRA web page ( [www.SOPRA-SA.com](http://www.SOPRA-SA.com)) for tutorial on ellipsometry principles, terminology and products.

