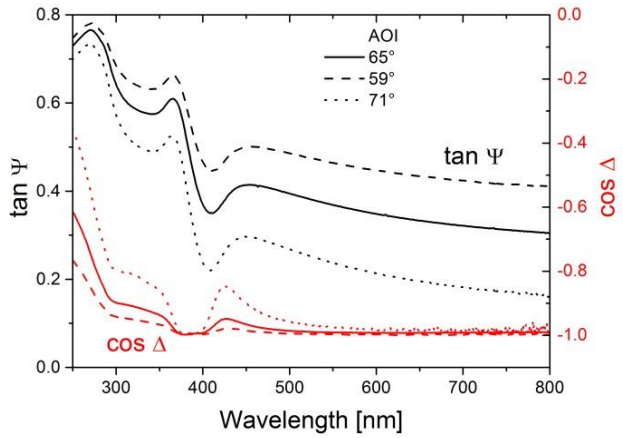
Spectroscopic ellipsometry, SIMS and X-ray diffractometry and reflectometry for Ge-graded SiGe HBT control

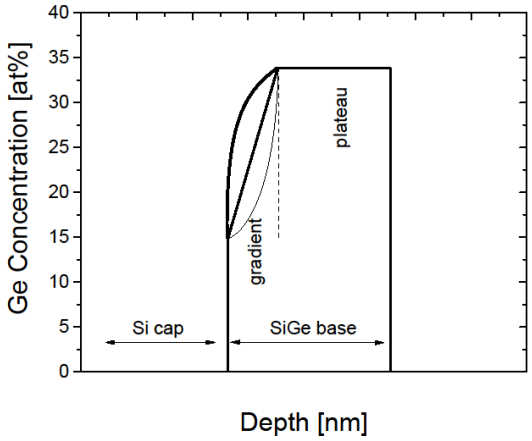
F. Bärwolf, O. Fursenko, P. Zaumseil and Y. Yamamoto

IHP, Im Technologiepark 25, D-15236 Frankfurt (Oder), Germany

SiGe BiCMOS process technologies require precise, fast, nondestructive and in-line thickness and composition control of Ge-graded HBT (Heterojunction Bipolar Transistor) layer stacks. In this contribution we demonstrated advantages and shortcomings of different characterization techniques such as spectroscopic ellipsometry (SE), dynamic secondary ion mass spectroscopy (DSIMS) and X-ray diffractometry (XRD) and reflectometry (XRR) for SiGe HBT with Ge graded profile up to 40%. Starting point of our investigation were HBT profiles described in [1, 2].

Thickness of Si-cap and SiGe base, splited into the gradient and plateau part, maximum Ge content, and shape of the Ge gradient part are measured and the error limits of the different techniques are discussed. The spectroscopic ellipsometry measurements were realized using automated KLA-Tencor SpectraFilm F1 ellipsometer with rotating polarizer and compensator at 3 angles of incidence (59, 65 and 71 deg). The sensitivity of spectroscopic ellipsometry to different shapes of the gradient part is demonstrated. DSIMS measurements were done with oxygen bombardment at low impact energy and compared with XRD.





Keywords: spectroscopic ellipsometry, SIMS; X-ray diffraction (XRD), X-ray reflection (XRR), SiGe HBT

References

[1] O. Fursenko, J. Bauer, P. Zaumseil, D. Krüger, A. Goryachko, Y. Yamamoto, K. Köpke, B. Tillack, Mat. Science in Semicond. Proces. 8 (2005) 273.
[2] P. Zaumseil, D. Krüger, R. Kurps, O. Fursenko, P. Formanek, Solid State Phenomena 95-96 (2004) 473.