

Effect of B₄C diffusion barrier on the thermal behavior of Sc/Si multilayers

H. Maury¹, P. Jonnard¹, K. Le Guen¹, J.-M. André¹, F. Delmotte², F. Bridou², M.-F. Ravet², S. Nanaronne³, N. Mahne³

(1) *Laboratoire de Chimie Physique – Matière et Rayonnement, Université Pierre et Marie Curie – Paris 6, CNRS – UMR 7614, 11 rue Pierre et Marie Curie, F-75231 Paris Cedex 05, France*

(2) *Laboratoire Charles Fabry de l'Institut d'Optique, CNRS, Univ Paris-Sud, Campus Polytechnique, RD 128, F-91127 Palaiseau cedex, France*

(3) *Dipart. di Ingegneria dei Materiali e dell'Ambiente, Università di Modena e Reggio Emilia, Via Vignolese 905, I-41100 Modena, Italy ; Laboratorio Nazionale TASC, INFN-CNR, s.s.14, km 163.5 in Area Science Park, I-34012 Trieste, Italy*

The spectral range between 35 and 50 nm is difficult to study because of the lack of high reflectivity materials. It has been shown that Sc/Si multilayers can be used for that purpose: simulated reflectivity around 70% and measured reflectivity around 40% [1-3]. However, the thermal stability of this system is poor because of the formation of metastable silicide interphases during its preparation. This is why B₄C thin diffusion barriers are introduced at the interfaces, even if they can diminish the optical performance at the wavelength of application.

The multilayers are prepared by magnetron sputtering. They consist of 40 Sc(5 nm)/Si(5 nm) or Sc(5 nm)/B₄C(0.9 nm)/Si(5 nm)/B₄C(0.9 nm) bilayers deposited on a silicon substrate. The multilayers are studied as-deposited and after annealing under argon atmosphere up to 400°C x-ray reflectivity (XRR) in the hard (0.154 nm) and soft (0.712 nm) x-ray ranges and x-ray emission spectroscopy (XES) [4]. XRR is used to obtain a geometric description of the stack (thickness and roughness of the various layers) and XES to know if interfacial silicides are formed. Diffuse scattering measurement at 12.7 and 31.5 nm are also performed on the as-prepared and 200°C annealed samples in order to understand the development of roughness upon annealing.

It is shown before annealing that the introduction of the barriers reduces the presence of the silicides at the interfaces and improves the optical performances at 0.712 nm. Upon annealing, the Sc/Si multilayer is stable only up to 200°C, after which a large decrease of the reflectivity is observed together with an increase of the silicides. For the Sc/B₄C/Si/B₄C multilayer, the optical reflectivity slightly decreases by 10% up to 400°C even if a 7% contraction of the period is determined and an evolution of the chemical state of the Si atoms between 300 and 400°C is detected.

[1] Y.A. Uspenskii et al., Nucl. Instrum. Phys. Res. Meth. A448, 147 (2000)

[2] N. Kaiser et al., Proc. SPIE 5250, 109 (2004)

[3] J. Gautier et al., Appl. Phys. A88, 719 (2007)

[4] H. Maury et al., Thin Solid Films 514, 278 (2006); H. Maury et al., Surf. Sci. 601, 2315 (2007)