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ABSTRACT

Nonlinear Reactive Diffusion of Amorphous Ni Silicide Nanometric Thin Films Upon Rapid Thermal Anneals

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The Ni monosilicide alloyed with Pt is extensively used as a contact material in advanced microelectronic devices, and a thorough understanding of silicide formation kinetics is crucial for process control. This study investigates the nature and growth kinetics of the first silicide phase formed during the solid-state reaction between Ni0.9Pt0.1 and Si.
The reaction between a 10 nm thick Ni0.9Pt0.1 film and Si (100) substrate was analysed after multiple rapid thermal annealing (RTA) processes. The silicide phase was identified to be amorphous using Fourier Transform of Transmission Electron Microscopy (TEM) images even when the substrate is not amorphous and its composition was determined by chemical TEM-Energy Dispersive X-ray (EDX) analyses. Silicide growth behavior was assessed by measuring silicide thickness using X-ray Reflectivity (XRR) after partial reactions induced by RTA at various temperatures and durations
The growth of the amorphous silicide does not follow the linear-parabolic model and, due to the nanometric thickness of the amorphous silicide layer, a nonlinear reactive diffusion model was developed to accurately fit the growth. This model enabled the determination of the effective diffusion coefficient and its activation energy. The study demonstrates the influence of the nanometric thickness and the high driving force on nonlinear diffusion in thin films and quantifies the impact of the amorphous substrate on kinetic parameters.

[1] D. Mangelinck, in: Handbook of Solid State Diffusion, Vol. 2, p. 379 (Elsevier, 2017).
[2] C. Delwail, K. Dabertrand, S. Joblot, F. Mazen, D. Mangelinck, Acta Mater. 262 119430S (2024).