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Properties of nickel silicide formed by rapid thermal processing of thin Ni layers on Si (001) S. ZOLLNER, S. BOLTON, D. JAWARANI, X. ZHU, R.B. GREGORY, J. ALVIS, R. NOBLE, M. JAHANBANI, B.-Y. NGUYEN, Freescale Semiconductor, Inc. — Transition metal silicides are used in the semiconductor industry as Ohmic (low-barrier) contacts between metal interconnects (Al, Cu, W) and implanted Si source, drain, and gate regions of CMOS transistors. Nickel silicide is particularly attractive in devices below 50 nm gate length, because 10 nm of Ni evaporated on Si consumes only 9 nm of Si to form 15 nm of low-resistivity NiSi at low annealing temperatures. However, the high diffusion rate of Ni in Si and the poor thermal stability of NiSi pose challenges for device integration. We compare the solid-state chemistry reactions of 10 nm Ni blanket layers with Si substrates under steady-state annealing and rapid thermal processing conditions. We find that rapid thermal annealing at 360C is equivalent to steady-state heating at 300C for 30 s and produces metal-rich Ni-Si phases. At lower thermal budgets, the Ni layer is not fully converted into Ni2Si and partially removed by selective etching in a sulfuric acid/hydrogen peroxide mixture. At higher temperatures, the reaction progresses further and produces monosilicide NiSi. This was investigated using x-ray fluorescence, powder x-ray diffraction, and x-ray reflectivity. At very high temperatures, NiSi agglomerates and the silicide film becomes discontinuous. Disilicide formation was not observed on our blanket layers, prevented by agglomeration.

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