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Thermal Stability of epitaxial $CoSi_2$ layer on (100) Si substrate from cobalt-carbon film deposited by MOCVD

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An epitaxial $CoSi_2$ layer was grown on Si (100) substrate from an amorphous cobalt-carbon (Co-C) film. The Co-C film was deposited on Si substrate by the metallorganic chemical vapor deposition (MOCVD) of $Co(\eta^5\text{-}C_5H_5)(CO)_2$ at 350 ℃. Uniform epitaxial $CoSi_2$ layers were successfully formed on Si (100) substrate by rapid thermal annealing (RTA) at 800 ℃ in N_2 ambient without inter-mediated layers and capping layers such as Ti or TiN. The Co-rich phases such as Co_2Si and CoSi were skipped above 500 ℃ in this work. The supply of Co by diffusion in the Co-C film seemed to be suppressed enough to form an epitaxial $CoSi_2$ layer.

The growth behavior of epitaxial $CoSi_2$ layers on Si (100) substrate was also investigated. The discrete $CoSi_2$ with large {111} faceted nuclei was grown on Si at the initial stage of reaction, depending on the thickness of as-deposited Co-C film. The nucleated $CoSi_2$ at the Co-C/Si interface begin to epitaxially grow toward the Si substrate with {111} and (100) interfaces. An epitaxial $CoSi_2$ comes to have a flat (100) interface after an additional annealing at the higher temperatures with cufficient reaction time to reduce the elastic strain energy.

The sheet resistance is little changed with the annealing above 850 ℃. The leakage current of the $p+n$ junctions without $CoSi_2$ contact is 5.6 nA/cm^2. After annealing at 1000 ℃ for 30 s, the leakage current measured on the junctions fabricated with the epitaxial $CoSi_2$ layer from Co-C films was as low as that of the as-fabricated junctions without $CoSi_2$. These results illustrate the good thermal stability of the epitaxial $CoSi_2$ even above 1000 ℃, indicating the potential application for the contact metallization in deep submicron devices.