Ni silicidation for Si fin and nanowire structures
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Introduction
Si nanowire FET(Si NW FET) is one of the good candidates for next generation devices. There is fear that parasitic resistance located at source and drain (S/D) contacts increase [1]. To effectively reduce the S/D resistance, Ni silicide technology has been investigated intensively and also excessive lateral growth of Ni silicide into Si NW has been reported[2]. But the growth mechanism has been yet to be understood. In this work, annealing time dependent lateral growth has been characterized for Si fin and nanowire(SiO2-covered) structures. And the thickness effect of SiO2 coverage to Si NW has been observed.

Experiments
Narrow Si fin structures were fabricated on a 30-nm-thick SOI wafer with width ranging from 15 to 60 nm by dry etching. SiO2-covered Si NW structures were fabricated by additional dry thermal oxidation of the fin structures, which results in formations of Si NWs with diameters ranging from 5 to 50 nm. The SiO2 cover was partially removed using the lithography definition and by dipping in buffered-HF in order to expose Si NW regions. 80-nm-thick Ni films were selectively deposited on Si fin and nanowire structures by RF sputtering. Then, the silicidation was performed by rapid thermal annealing (RTA) at 500 °C in nitrogen ambient. Finally, the lateral growth of Ni silicide was observed by a scanning electron microscope (SEM).

Results and discussion
Figure1 show the dependency of the growth length on annealing time. This indicated that growth length is proportional to the square root of annealing time. Therefore, Ni silicide lateral growth for Si fin and nanowire structures is controlled by Ni diffusion. The difference exists between the diffusion coefficients for the two structures due to the effect covered with SiO2. From the obtained diffusion coefficient of Si fin the mechanism of the silicidation lateral growth for fin is controlled by Ni diffusion. On the other hand, in case of nanowire (SiO2-covered), interface diffusion of Si/SiO2 or different diffusional mechanism such as GBD and volume diffusion is understood as the lateral growth mechanism. As effect of oxide which covers Si NW considered, one denoted that the lateral growth of Ni silicide depend on the oxide thickness. As a result the growth length indicated trend as red dot-line in Fig1. Therefore, when the oxide thickness become about 15nm, the growth length may be the minimum value and it was denoted that these relationships are not simple - no trend as gray broken line in Fig2.

Conclusions
The annealing time dependence of the growth length for both structures has shown similar relationships with square root of annealing time but the difference of diffusion coefficients exists. These results indicate that the growth length of Ni silicide is controlled by Ni diffusion. For Si fin structure, surface diffusion of Ni may be appeared. On the other hand, in case of the NW (SiO2-covered), diffusion on Si/SiO2 interface or different diffusional mechanism may be the lateral growth mechanism. As effect of oxide which covers Si NW considered, one denoted that the lateral growth of Ni silicide depend on the oxide thickness. As a result the growth length indicated trend as red dot-line in Fig1. Therefore, when the oxide thickness become about 15nm, the growth length may be the minimum value and it was denoted that these relationships are not simple - no trend as gray broken line in Fig2.

References