# $SiO_2$上横方向成長を用いた極低貫通転位密度 Ge 薄膜

## Ultra-low threading dislocation density Ge film by lateral overgrowth on $SiO_2$

○八子 基樹[1]、和田 一実[1]（1. 東大院工）
○Motoki Yako[1], Kazumi Wada[1] (1. Univ. of Tokyo)
E-mail: kwada@material.t.u-tokyo.ac.jp

**[Introduction]** Ge is a promising material for on-chip devises on Si photonics platform. The challenging issue of Ge on Si is threading dislocations (TDs) due to the lattice mismatch between Ge and Si. TDs behave as the leak pass in photo-detectors and the non-radiative recombination center in LEDs [1]. Epitaxial lateral overgrowth (ELO) is one of the techniques to reduce TD density (TDD) [2, 3]. Ge film formed over patterned $SiO_2$ has lower TDD (~$10^6$ /$cm^2$) than that of Ge film on intrinsic Si wafer ($10^{8\sim9}$ /$cm^2$). Remained problem on the ELO technique is TDs formed when Ge seeds coalesce (coalescence TDs). Thinner $SiO_2$ mask is employed to reduce the coalescence TDs in present work.

**[Experimental]** Thermal oxide is formed on Si wafers and line-shape Si growth seeds are exposed by wet etching using buffered-HF solution. Ge was grown over the patterned wafers by Ultra High Vacuum CVD employing step growth until uniform Ge film is obtained; low temperature buffer growth followed by high temperature main growth. Cross sectional TEM observation, etch pit density (EPD) measurements and XRD measurements were employed.

**[Ge coalescence]** Ge grown from the line-shape Si seeds coalesces and forms the flat film leaving air voids over the $SiO_2$. It is notable that no TD is shown in the coalesced Ge film. Considering sample thickness and observed width, TDD should be lower than $10^8$ /$cm^2$.

**[Coalesced Ge film quality]** EPD measurements are employed to characterize Ge films. 10 μm x 10 μm area AFM measurements (Fig. 1) show clear difference between (a) coalesced Ge and (b) blanket Ge on the same wafer. The coalesced Ge shows no etch pit (corresponding EPD ≤ $10^6$ /$cm^2$) while the blanket Ge shows etch pits at a density of 7.2 x $10^7$ /$cm^2$. Concrete EPD of the coalesced Ge is given by top view observation by optical microscope as 8 x $10^4$ /$cm^2$.

**[Conclusion]** Ge grown from line-shape Si seeds coalesces and forms flat film. The coalesced Ge over the thin $SiO_2$ mask has ultra-low EPD as 8 x $10^4$ /$cm^2$.

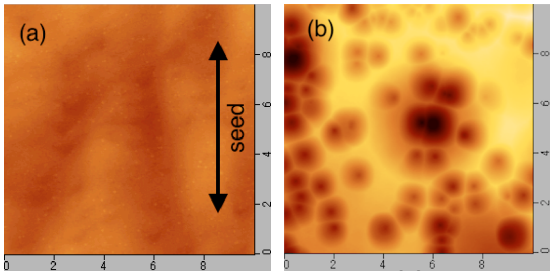


Fig. 1 Etch pit measurement by AFM on
(a) coalesced Ge and (b) blanket Ge

**[References]** [1] Y. Ishikawa et al., IEICE Elect. Exp., **11**, 24, 1-17 (2014). [2] T. A. Langdo, et al., Appl. Phys. Lett. **76**, 3700 (2000). [3] J.-S. Park, et al., Appl. Phys. Lett. **90**, 052113 (2007).