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Annealing-induced enhancement of ferromagnetism and nanoparticle formation in ferromagnetic-semiconductor GeFe[1] YUKI WAKABAYASHI, YOSHISUKE BAN, SHINOBU OHYA, MASAAKI TANAKA, The Univ. of Tokyo — Ge-based ferromagnetic semiconductor GeFe is a promising material for future Si-based spintronic devices because of the high-quality single crystallinity and good compatibility with Si. However, its Curie temperature (T_C) is currently at the highest 170 K. In this study, we investigate the annealing effect on GeFe in order to enhance the ferromagnetism. The $Ge_{0.895}Fe_{0.105}$ thin film was epitaxially grown on a Ge(001) substrate by low-temperature molecular beam epitaxy. Then, post-growth annealing was carried out. We have analyzed GeFe films both crystallographically and magnetically by using transmission electron microscopy, transmission electron diffraction, energy-dispersive X-ray spectroscopy, magnetic circular dichroism, and superconducting quantum interference device. We have successfully increased the T_C of $Ge_{0.895}Fe_{0.105}$ up to $\sim$ 220 K while keeping a single ferromagnetic phase when the annealing temperature was lower than 500°C. In contrast, when annealed at 600°C, single-crystal GeFe nano-particles with stacking faults and twins, which have a high T_C nearly up to room temperature, were formed in the film. Both types of films have a flat surface (roughness of 2-5 MLs), and thus they are promising for Si-based spin devices.

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