1. Abstract

By forming aluminum oxynitride on the Ge (Germanium) layer, high reliability thin film as the gate insulating film of MOSFET was realized. High-pressure inert gas post deposition annealing (PDA) using N₂ or Ar gas dramatically improved the electrical properties of AlON/Ge MIS gate stacks.

2. Ge MOSFET: Expectation, and Problems to be Solved

Ge which has the higher carrier mobility, is a promising candidate as a channel material in the next generation of MOSFETs. In miniaturized MOSFETs, gate insulators with a high dielectric constant (high-k) are required in order to suppress the gate leakage current and the short channel effects. There is also a problem how good interface and insulating layer on Ge can be realized.

3. Scalable High-k/Ge Gate Stack Technology

We investigated the use of aluminum oxynitride film (AlON) as a gate insulating film formed on the Ge substrate. By using an AlON film, a thin EOT (Equivalent Oxide Thickness) is possible. However, heat treatment of AlON film in order to improve the quality of the AlON film deteriorates the interface between Ge substrate and the AlON film. After examining the conditions under which the interface between the AlON film and the Ge substrate is not degraded by heat treatment, we tried to apply high-pressure N₂ post-deposition annealing (HPN PDA) in order to suppress the N₂ desorption, which was analogous to high-pressure oxidation (HPO) annealing in GeO₂/Ge stack.

HPN PDA dramatically improves the C-V characteristics, whereas the large interface states were observed in the same gate stack as a result of atmospheric-pressure N₂ (APN) post-deposition annealing. HPN PDA also reduces the gate leakage current. HPN PDA only improves the interface in the case of thin AlON/Ge.

C-V Characteristics (a) and I-V Characteristics (b)

Au/3nm-thick AlON/p-Ge100/Al MIS capacitors in APN and HPN PDA at 500 and 600 degree.

C-V Characteristics

Au/3nm-thick and 24nm-thick AlON/p-Ge100/Al MIS capacitors in HPN PDA at 500 degree for 5min.

Patent Licensing Available

Patent No.: WO2014/030371

JST/ IP Management & Licensing Group Phone: +81-3-5214-8486 E-mail: license@jst.go.jp