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Memory characteristics of MOSFET with silicon nanocluster double layers

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Si nanocluster double layers memory in a MOSFET structure was investigated. The structures were created with up to two layers of size-controlled Si nanoclusters having a size of around 7 nm. The Si nanoclusters were deposited by using the pulse-type gas-feeding technique in low pressure chemical vapor deposition (LPCVD)system. The details of pulse-type gas-feeding technique were described in the previous work[1].

In this work, The MOSFET Si nanocluster memory device was fabricated on the p-type (100) Unibond SOI wafers with a 100 nm top Si layer and a 200 nm buried oxide layer. Active Si region, which will be the channel and source/drain, was fabricated by photolithography and plasma reactive ion etching processes. Then, a 5 nm thick SiO_2 was thermally grown in a dry oxidation furnace to prepare the tunneling oxide layer in the Si nanocluster floating gate memory structure. Si nanoclusters were deposited on the tunneling oxide layer by using the pulse-type gas-feeding method in LPCVD. One or two layers of silicon nanocluster were deposited by LPCVD at 640 ℃ with helium-diluted 5 % SiH_4 as a source gas. Furthermore, two layers of silicon nanocluster were separated by a 10 nm thick SiO_2 using LPCVD at 400 ℃ with mixed gases of SiH_4 and O_2. The density of the silicon nanocluster whose size is 7 nm in average diameter was about 7×10^{11} #/cm^2. And 30 nm SiO_2 as a control oxide was deposited on the Si nanoclusters layer with SiH_4 and O_2 at 400 ℃by using LPCVD. Poly-Si as a gate electrode was deposited on the control oxide with SiH_4 at 640 ℃ by using LPCVD, then gate electrode was patterned. Finally, source/drain/gate doping process was carried out by using the phosphorus plasma doping method at 500 ℃.

We fabricated a MOSFET structure with the double Si nanoclusters layers in the gate oxide and investigated the memory characteristics, which will be discussed.

[References]

[1] Chan Park, Kyoungmin Kim, Eunkyeom Kim, Junghyun Sok, Kyoungwan Park, Moonsup Han, Materials science and engineering B, Volume 140, Issues 1-2, 25 May 2007, Pages 103-108