Silicon-on-Insulator-Multilayer Structure Fabricated by Epitaxial Layer Transfer

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Silicon on insulator (SOI) is a critical material for future electronic integrated circuits. Buried silicon oxide layer provides electrical isolation and corresponding a significant reduction of parasitic capacitance, which makes SOI devices with high performance. But heat generated in high power device itself will degrade the device electrical characteristics, and the low thermal conductivity of silicon oxide becomes critical. Si_3N_4 is a good choice for buried layer because of its high thermal conductivity. Nitrogen ion implantation into silicon was used to fabricate SIMNI with Si_3N_4 buried layer, but it was hard to obtain good quality Si_3N_4. In this paper, epitaxial layer transfer technology was used and high quality silicon-on-insulator-multilayer (SOIM) structure with Si_3N_4 was obtained.

Ultra-high vacuum electron beam evaporator was used to grow single crystal Si on porous silicon formed by electrochemical method. Si_3N_4 was deposited on another silicon wafer with LPCVD, and then silicon oxide was deposited on it. After bonding the two wafers, splitting was carried out in the porous silicon layer and remnant porous silicon was removed by etching. Thus the SOIM structure was obtained. The structure quality was investigated by high-resolution cross-sectional transmission electron microscopy, atomic force microscopy and spreading resistance profile. Software named MEDICI was also used to simulate the self-heating effect in the SOI MOSFET with new structure.

Measurement results show that the SOIM has good quality. (See fig.1) The epitaxial Si layer has the similar crystalline quality as the substrate Si. Si_3N_4 layer is amorphous and has smooth and steep interface. Simulation results indicate that the new structure can reduce self-heating in devices efficiently. It can be considered that SOIM fabricated by epitaxial layer transfer should be a good candidate to be used for device where thermal effects are taken into account.

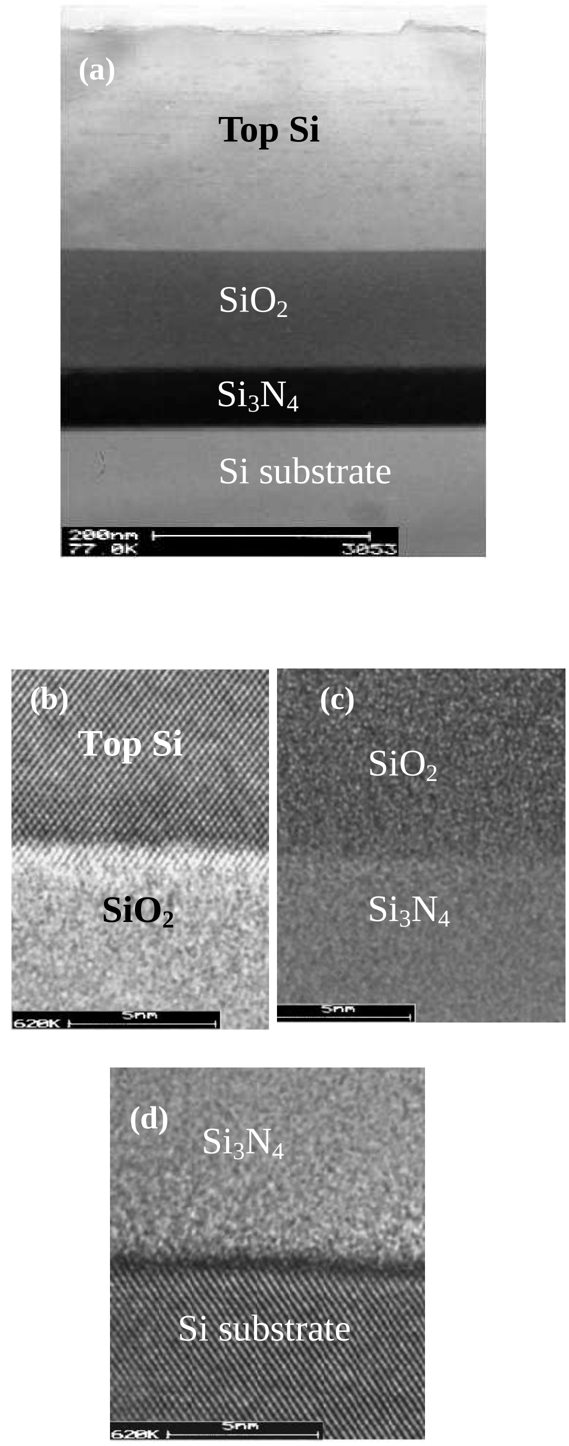

Figure 1 Microstructure of $Si/SiO_2/Si_3N_4/Si$ (a), interface between top Si and buried silicon oxide (b), interface between SiO_2 and Si_3N_4 (c) and interface between Si_3N_4 and Si substrate (d)