SrTiO$_3$ single crystal field-effect transistor with an amorphous CaHfO$_3$ gate insulator

KEISUKE SHIBUYA, TSUYOSHI OHNISHI, TAKAYUKI UOZUMI, MIKK LIPPMAA, The University of Tokyo, HIDEOMI KOINUMA, Tokyo Institute of Technology — It becomes more and more important to understand the electronic properties of interfaces in transition-metal oxides from a viewpoint of utilizing such materials in devices; tunneling magnetoresistance (TMR) junctions, resistance random access memory (RRAM), or field-effect transistors (FET). SrTiO$_3$ is a wide-gap semiconductor and a good model system for studying the electronic structure of various oxides with similar crystal structures. We have fabricated a field-effect transistor composed of SrTiO$_3$ (100) single crystal as a channel and an amorphous CaHfO$_3$ layer as a gate insulator. The amorphous CaHfO$_3$ gate insulator layer, grown by pulsed laser deposition, was atomically flat and had an average breakdown field of 5 MV/cm. All electrode and channel patterning was done with simple contact masks. The device showed prominent n-type transistor operation, a field-effect mobility of 0.4 to 0.5 cm$^2$/V s, and an on-to-off channel current ratio of $\sim 10^5$ at room temperature. However, an improvement of these transistor properties was not observed at low temperatures. The device performance was limited by the electric structure of the interface.

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