Abstract
Metal Insulator Semiconductor Field Effect Transistor (MISFET) is a device dominated by interface quality. Low-frequency noise technique has been used to determine silicon-insulator interface quality. This work presents the low-frequency noise and related electrical characteristics of NMIS transistor with lanthanum oxide as the gate dielectrics. Low-frequency noise measurements were carried out in linear region with \( V_D = 100 \) mV.

Introduction
Excellent result of lanthanum oxide as high-k gate dielectrics has been reported \[1\][2]. Good silicon-insulator interface qualities are highly demanded in replacement of silicon oxide with high-k gate materials. In this paper, we present low-frequency noise and related electrical characterizations of NMIS transistor with lanthanum oxide as the gate dielectrics.

Experiments
Lanthanum oxide thin film was deposited at 250°C over \( \text{H}_2\text{O}_2 \) dipped substrate by e-beam evaporation with physical thickness of \( t_{\text{ox}} = 7 \) nm. The film was annealed under \( \text{O}_2 \) ambient at 400°C. Aluminum was used as the gate metal and patterned with photolithography. The device electrical characteristics were measured with Agilent 4156C Device Semiconductor Parameter Analyzer. Ultra Low Noise DC Source PA14A1 of Shibasoku was used for biasing the device for low-frequency noise measurement. Drain noise signals were coupled in Low Noise Amplifier powered with batteries. Noise measurements in different drain bias current were carried out in 10 Hz to 10 kHz frequency range using Agilent 89410A Vector Signal Analyzer. All measurement systems were shielded with ground system.

Results and Discussion
The device characteristics of NMIS transistor with channel area of \( W \times L = 27 \mu m \times 2.5 \mu m \) are shown in Figure 1, Figure 2 and Figure 3. Figure 1 shows the \( I_D-V_D \) characteristics with different applied gate voltages. Figure 2 shows transfer characteristics measured at \( V_D = 100 \) mV. Figure 3 shows low-frequency noise characteristics of NMIS transistor measured with different drain bias currents. These results suggest that the device has low current noise spectral density of about \( 1.6 \times 10^{-20} \) A\(^2\)/Hz@1 kHz for \( I_D = 1-50 \) \( \mu \)A.

Conclusions
Low-frequency noise and related electrical characterizations of NMIS transistor with lanthanum oxide as the gate dielectrics were evaluated. Low current noise spectral density of \( 1.6 \times 10^{-20} \) A\(^2\)/Hz@1 kHz for \( I_D = 1-50 \) \( \mu \)A was measured.