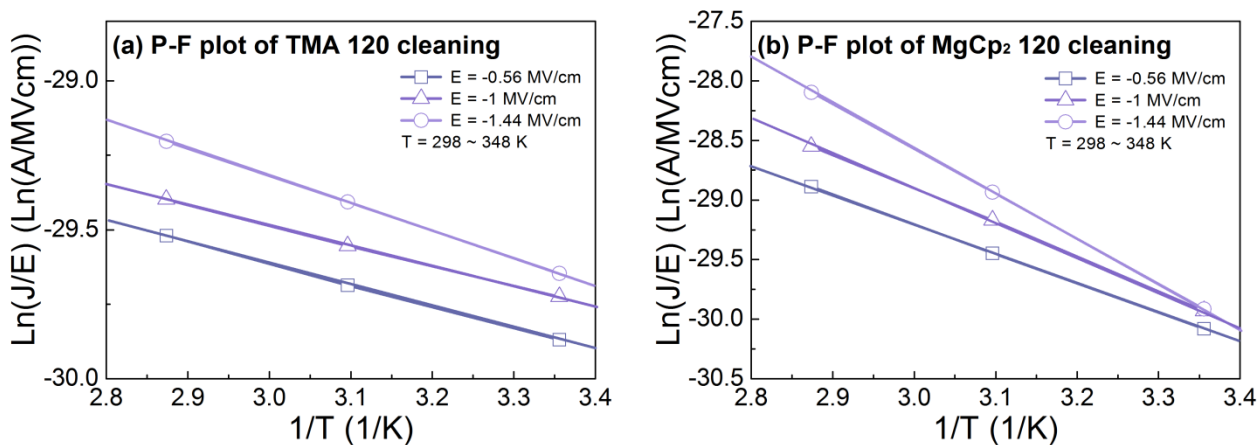


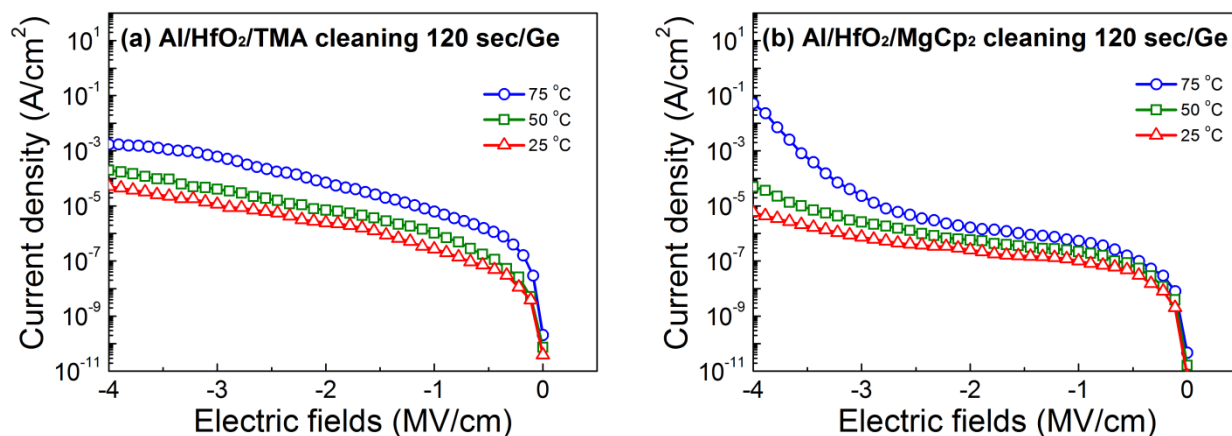
Supporting Information

In Situ Surface cleaning on a Ge Substrate using TMA and MgCp₂ for HfO₂-based Gate Oxides

Il-Kwon Oh,^a Kangsik Kim,^b Zonghoon Lee,^b Jeong-Gyu Song,^a Chang-Wan Lee,^a David Thompson,^c Han-Bo-Ram Lee,^d Woo-Hee Kim,^e Wan Joo Maeng^{f*} and Hyungjun Kim^{a*}



Supporting information 1 Poole-Frenkel conduction by doping temperature-dependent J_g measurement, (a) TMA 120s cleaning and (b) MgCp₂ 120s cleaning one. The fitted line slope of $\ln(J/E)$ versus $1000/T$ yields the trap energy levels from the conduction band of HfO₂, the effective values of which were determined to be 0.64 and 0.53 eV for 120s TMA- and MgCp₂-cleaned samples, respectively. This indicates that the trap energy levels of the 120s MgCp₂-cleaned sample are slightly lower than those of the 120s TMA-cleaned sample.



Supporting information 2 I-V curves of MOS capacitors with (a) TMA 120s cleaning and (b) MgCp₂ 120s cleaning measured at 25, 50, and 75 °C. At high temperatures, since the trap energy level of the 120s MgCp₂-cleaned sample is closer to the conduction band minimum, the leakage currents of the 120s MgCp₂-cleaned sample are larger than those of TMA.

Notes and references

^a School of Electrical and Electronics Engineering, Yonsei University, 262 Seongsanno, Seodaemun-gu, Seoul, Korea

^b School of Materials Science and Engineering, Ulsan National Institute of Science and Technology (UNIST), UNIST-gil 50, Eonyang-eup, Ulju-gun, Ulsan, 689-798, Korea

^c Applied Materials, Sunnyvale, CA 94085, USA

^d Department of Materials Science and Engineering, Incheon National University, 119 Academy-ro, Yeonsu-gu, Incheon, Korea

^e Department of Chemical Engineering, Stanford University, 381 North-South Mall, Stanford, California 94305, United States

^f Department of Materials Science and Engineering, University of Wisconsin Madison, Madison, Wisconsin 53706, USA