Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Large Area CVD MoS2 RF transistors with GHz performance MARUTHI NAGAVALLI YOGEESH, ATRESH SANNE, SAUNGEUN PARK, DEJI AKINWADE, SANJAY BANERJEE, Microelectronics Research Center, University of Texas at Austin — Molybdenum disulfide (MoS_2) is a 2D semiconductor in the family of transition metal dichalcogenides (TMDs). Its single layer direct bandgap of ˜1.8 eV allows for high I_{ON}/I_{OFF} metal-oxide semiconducting field-effect transistors (FETs). More relevant for radio frequency (RF) wireless applications, theoretical studies predict MoS_2 to have saturation velocities, v_{sat} >310^6 cm/s. Facilitated by cm-scale CVD MoS_2, here we design and fabricate both top-gated and embedded gate short channel MoS_2 RF transistors, and provide a systematic comparison of channel length scaling, extrinsic doping from oxygen-deficient dielectrics, and a gate-first gate-last process flow. The intrinsic f_T (f_{max}) obtained from the embedded gate transistors shows 3X (2X) improvement over top-gated CVD MoS_2 RF FETs, and the largest high-field saturation velocity, v_{sat} = 1.88 10^6 cm/s, in MoS_2 reported so far. The gate-first approach, offers enhancement mode operation, I_{ON}/I_{OFF} ratio of 10^8, and the highest reported transconductance (g_m) of 70 $\mu S/\mu m$. By manipulating the interfacial oxygen vacancies in atomic layer deposited (ALD) HfO_{2-x} we are able to achieve 2X current density over stoichiometric Al_2O_3. We demonstrate a common-source (CS) amplifier with voltage gain of 14 dB and an active frequency mixer with conversion gain of -15 dB. Our results of gigahertz frequency performance as well as analog circuit operation show that large area CVD MoS_2 may be suitable for industrial-scale electronic applications.

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Date submitted: 22 Nov 2016 Electronic form version 1.4